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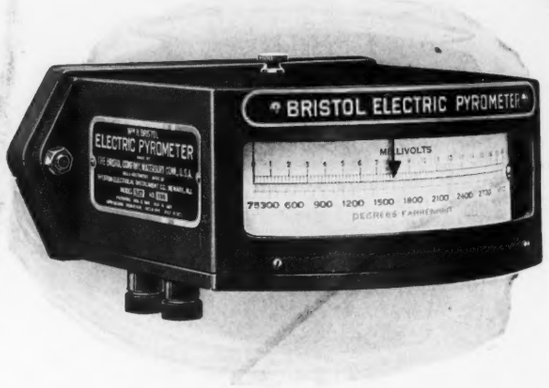

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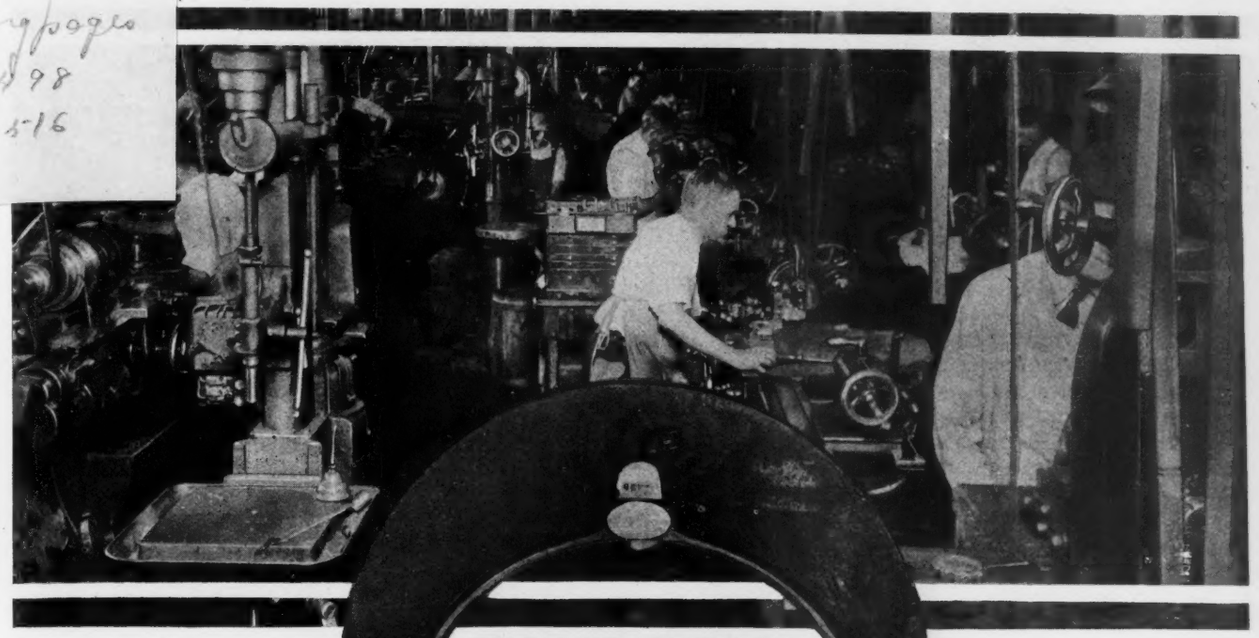


Gage Making in a Shell Plant

Sixth of a Series of Articles Describing Methods Employed in a Plant Making the United States Seventy-five Millimeter Shell

Important Features of the Practice in Making Working and Inspection Gages and Maintaining them within the Required Limits

By Franklin D. Jones[1]

IN a plant producing over ten thousand shells every twenty-four hours, new gages are required frequently, and it is necessary to inspect continually and systematically the gages which are in use, to insure maintaining them within whatever limits or tolerances may have been prescribed. Shell making in a large plant requires not only quite a large variety of gages, but also many duplicate gages, since many operators are working simultaneously on different shells of the same size. These gages are, of course, continually wearing, the amount of wear varying considerably according to the type of gage and the skill exercised in using it. In this article, some of the more important features of the gage making practice in a certain well-organized shell making plant will be described.

The work of the gage department may be divided into (1) originating or designing new gages; (2) making new gages; (3) checking working and inspection gages; and (4) repairing gages which have worn beyond the allowable limits of accuracy. New gages may be needed because of changes in dimensions or because it has been decided to replace an existing gage with an improved form. After each gage leaves the gage department for use, either as a working or inspection gage, it is periodically inspected. The inspector is continually making the round of the shop, passing from one user of gages to another until every gage has been tested with the standards with which the inspector is provided. As soon as the accuracy of the complete gaging equipment has been verified in this way, the work of inspection begins all over again, several of these tours of inspection being made daily. Whenever a gage is found to be either below the minimum or above the maximum size, it is sent to the gage department for correction and an accurate gage is given to the operator in exchange.

[1]Associate Editor of MACHINERY.

Periodically, the set of standards used by the inspector is checked by the foreman of the gage department. A group of the gages used in the shell plant referred to is shown in Fig. 1. This view does not illustrate all of the gages required for shell work, but examples of the different forms. For instance, quite a number of snap gages of different sizes are used to measure different parts of the shell during various stages of the work. Then, there are other more special designs required, as, for instance, those shown in Fig. 2. The gage shown at *A* is an interesting type that is used for testing the concentricity of the thread in the nose of the shell. If this thread is not exactly concentric with the body of the shell, and the fuse is off center, the shell will wobble in flight and not follow its natural path. This gage has a central plug which is a very close fit in its hole. At the end of this plug there is a thread which will screw into the end of a perfectly concentric shell when the latter is held in the close-fitting ring formed at the enlarged end of the gage body. Gage *B* is for testing the thickness of the shell wall. The movable gage point is withdrawn by a pivoted thumb latch, and marks on the gage point show whether the wall thickness is within the allowable minimum and maximum limits. The gage *C* to the right is for testing the thickness of the base. The shell is simply placed in a vertical position within the gage, and a rod in the center is lowered into contact with the inside of the shell base. Lines on the upper end of the rod then indicate whether or not the thickness is correct.

Materials Used for Gages

The gages are made either of carbon tool steel, machine steel, or a special manganese steel. Most of the gages, except thread gages, are made of carbon steel containing 0.85 to 0.95 per cent carbon. Machine steel is used for the drop-forged snap gages, but very little for other forms. One reason why

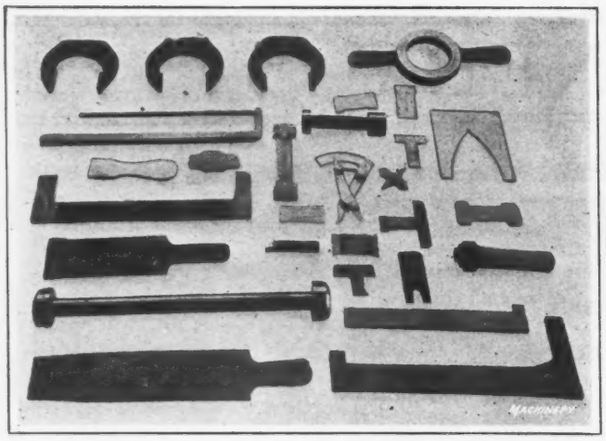


Fig. 1. Various Forms of Gages used in a Shell Plant for inspecting the U. S. 75-millimeter Shell

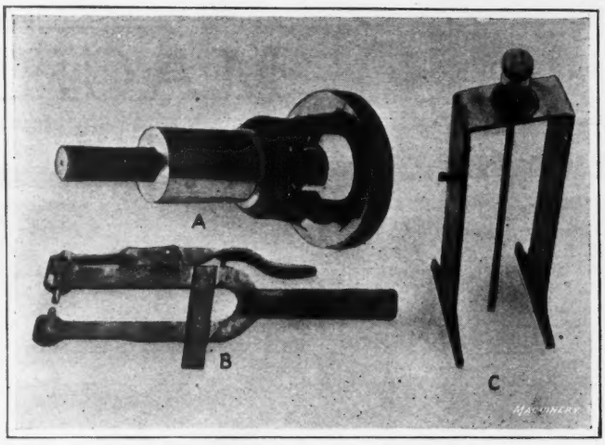


Fig. 2. Gages for testing Concentricity of Shell Nose Thread, Thickness of Wall, and Base

machine steel is not used very much in this particular plant is that a much longer time is required for pack-hardening the machine steel than for hardening a high-carbon steel, which is considered an important feature. Another disadvantage referred to in connection with the pack-hardened machine steel gages is that the thin hardened surface is removed by regrinding worn gages, and heat-treatment is again necessary, which increases the expense for gage repair. The thread gages are made of a special high-manganese steel known as "Mangano" (made by the Latrobe Electric Steel Co., Latrobe, Pa.). This is an oil-hardening steel, which is used because it does not contract, expand, or otherwise change its shape in hardening like an ordinary tool steel.

Roughing out Gages

Standard machine tools, such as lathes, milling machines, etc., are, of course, used for machining different kinds of gages to the approximate size, the method of roughing out the different gages depending more or less upon their form. This part of the work, however, is often facilitated in many cases by the use of the bench grinder and filing machine. The bench grinder is used on various forms of gages made of flat or sheet stock. The gage is held on a suitable rest and is guided by hand for grinding it to the approximate shape and size required after rough-machining. The filing machine shown at work in Fig. 3 is also very useful in connection with the work of the gage department. This illustration shows a stack of T-shaped limit gages being filed. These gages are soldered together temporarily, and they are filed on this machine to within about 0.010 inch of the required dimensions.

Fig. 3. Roughing out Gages on Filing Machine

Heat-treatment of Gages

In the heat-treatment of gages, the essential points are to prevent warping, to harden those parts which require hardening, and, at the same time, to leave any sections of the gage soft if this is necessary, either as a means of preventing warping or to increase the toughness of the steel wherever breakage is likely to occur when the gage is in use. The methods of hardening several different forms of gages will be described to illustrate how the results referred to are obtained.

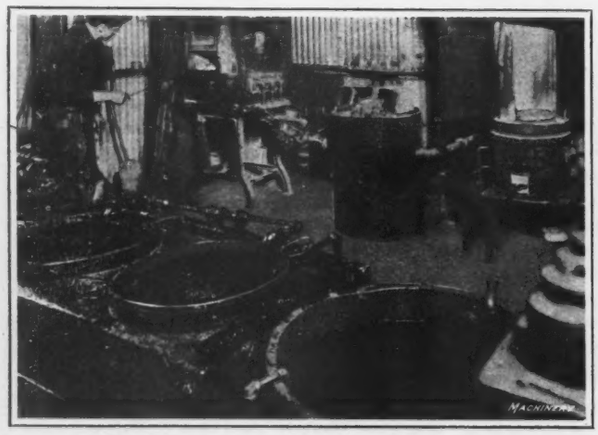


Fig. 4. A Corner in the Hardening Department

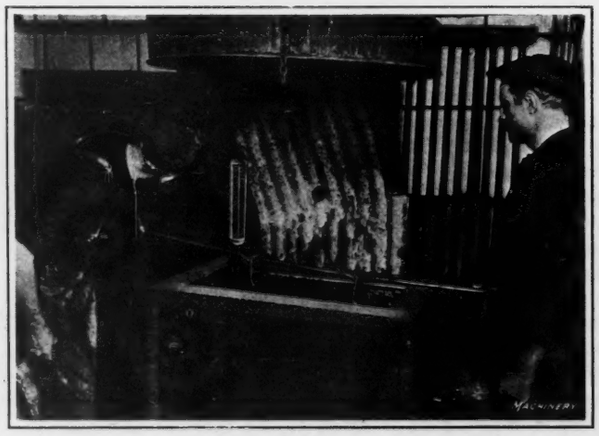


Fig. 5. Oil Bath in which Gages are tempered

Fig. 4 is a view of one corner of the hardening department; the gas furnace is shown to the left, the preheating forge in the center, and the lead bath to the right in the background, and the oil baths and water tank for quenching in the foreground. Steam pipes which enter the bath of quenching water are used to maintain it at a temperature of 110 degrees F. The oil hardening and tempering furnace is shown in Fig. 5. The men shown in this particular view are about to remove from the oil tempering bath the wire basket containing gages.

Before the gages are heated in the gas furnace, they are

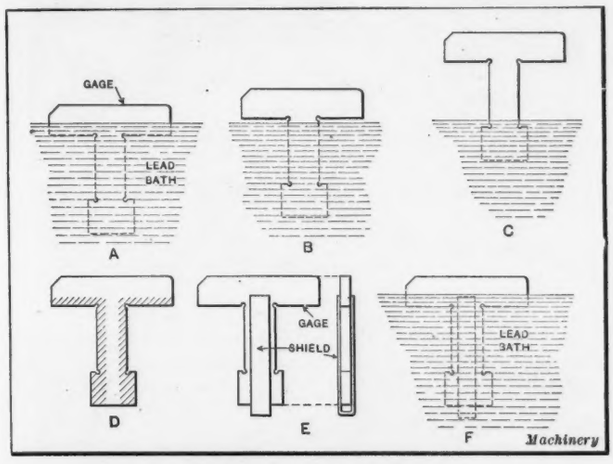


Fig. 6. Two Methods of hardening Gages

preheated to about 1100 degrees F. over a coke fire. The gage is first placed upon a plate, which may be seen in Fig. 4, just above the bed of coke on the preheating forge. When the work is partially heated, it is removed from the plate and inserted in the coke fire, from which it is transferred to the gas furnace at the left. Thread gages made of "Mangano" steel should be heated uniformly and slowly to about 1425 or 1435 degrees F., and they are hardened by quenching in fish oil, although lard or cottonseed oils might also be used. Gages made of 0.85 to 0.95 per cent carbon steel are preheated over the coke fire and then heated to the hardening temperature of about 1440 to 1450 degrees F. The tempering temperature depends upon the method of using the gage. For instance, the gages used by machine operators are drawn to about 230 degrees F., or just enough to remove the hardening strains. It has been found by experience that tougher gages are needed for use in connection with bench work, etc., to prevent breakage, and the drawing temperature is about 530 degrees F.

Use of Lead Bath for Gage Hardening

The lead bath is used quite extensively for hardening gages, especially when only certain parts of the gage need to be hardened. The object of partially annealing sections of some of the gages is to toughen them and prevent breakage. One method of hardening a T-shaped limit gage is illustrated diagrammatically at *A*, *B*, and *C*, Fig. 6. The gage is first dipped in the lead bath to the depth indicated at *A*, the bath having a temperature of 1450 degrees F., approximately. The gage is then quenched in water. The end of the gage is next dipped in the lead bath to the depth shown at *B*, thus partially annealing this end. The lower gaging end is finally dipped in the lead, as shown at *C*, and is quenched. In this way, the central part of the gage is left comparatively soft and tough.

Ring gages similar to the form shown in the upper right-hand corner of Fig. 1 are first hardened all over and then the handles projecting from each side are softened in the lead bath so they cannot readily be broken off. These gages are made from 0.85 to 0.95 per cent carbon steel, and they are at first hardened all over by heating to about 1450 degrees F. and then quenching in water. The temper is then drawn to 300 degrees F. in the oil bath, and finally each handle is completely immersed in the lead, leaving the ring section hard.

Hardening Long Length Gages

The long flat gages such as are used for checking the overall lengths of shells are hardened locally or on the gaging ends only, in order to prevent warping and at the same time make the gage less brittle and better able to withstand shocks. The three diagrams *A*, *B*, and *C*, Fig. 7, illustrate the method of procedure. One end of the gage is hardened at a time by holding the gage at an angle of about 45 degrees and immersing the end as illustrated at *A*. The heated end is quenched in water and is then polished so that temperature colors will be visible. The hardened end is next partially submerged in the bath as at *B*, and it is held in this position until a slight color begins to show on that part of the gage end which is above the lead bath. In order to prevent this gaging surface from becoming overheated, the position of the gage is reversed and it is submerged in the water bath as illustrated at *C*.

Use of Shield Tongs in Gage Hardening

For some forms of gages, special shield tongs are used when quenching in order to prevent the portion covered by the tongs from hardening. The use of these tongs as applied to a flat gage *D*, Fig. 7, is illustrated at *E*. This gage is made of 3/16-inch flat steel, and it is used for testing the position of the copper driving band and of the bourrelet. The bourrelet is the name given the enlarged part of the shell just back of the curved portion or nose. It is a few thousandths inch less in diameter than the diameter across the lands of the rifling and steadies the shell as it leaves the gun. After the gage is preheated, it is placed edgewise on a flat cast-iron plate in the gas furnace and heated to a hardening temperature of about 1450 degrees F. The gage is removed from the furnace by means of the shield tongs which cover most of the body, as illustrated at *E*, Fig. 7; consequently, when the gage is quenched that part protected by the tongs is not hardened to any extent. The next step is to soften about half of the projecting gage end by immersing it in a lead bath as illustrated at *F*. If the entire projecting end were left hard, it might easily be broken, but by dipping this end in the lead bath to the depth shown, the outer portion, which is not used for gaging, is softened and made tough without interfering with the hardened gaging surface.

Another form of gage requiring the use of the shield tongs is illustrated at *G*, Fig. 7. This is also made of flat stock and is used for testing the inside taper of the shells. It is a diffi-

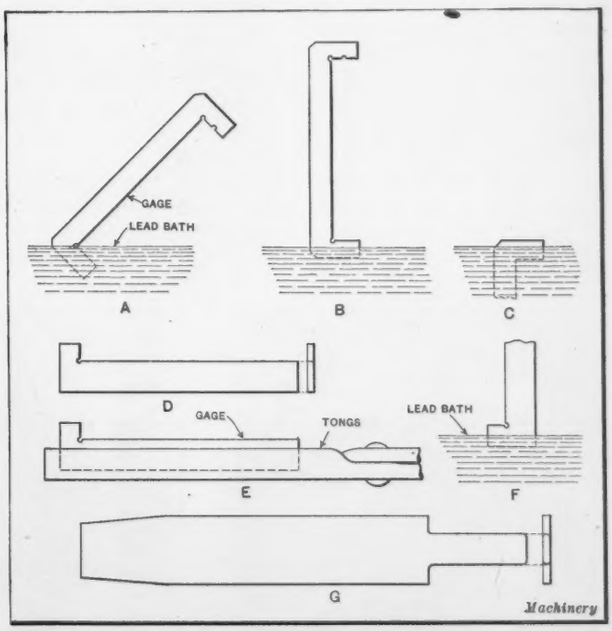


Fig. 7. Diagrams illustrating how Long Flat Gages are hardened to prevent Distortion and Breakage

cult gage to harden without distortion unless the work is done properly. This gage, like the preceding one, is placed edgewise on a flat cast-iron plate while heating to the hardening temperature. This plate should extend the full length of the gage and it prevents the latter from warping while in the furnace. The gage is first inserted with the taper point inward, and when it has been heated to about 1300 degrees

Fig. 8. Flat Gage held by Shield Tongs when quenching in Order to leave Central Portion Soft

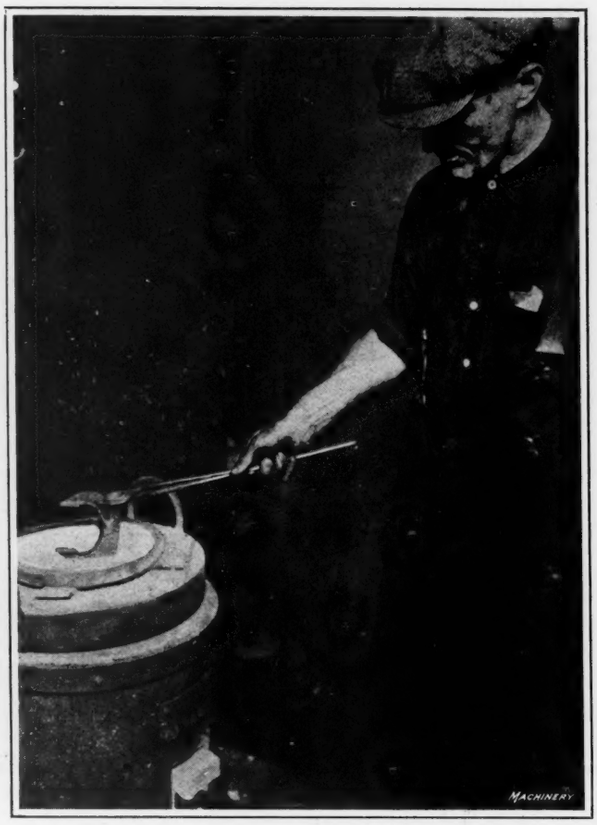


Fig. 9. Reducing Hardness and Brittleness of Snap Gage where Breakage is likely to occur

F., it is turned around so that the point is toward the furnace door in order to insure uniform heating. Fig. 8 shows how the shield tongs are applied to this gage for quenching it. Each edge is exposed to the water and the central portion is left soft. After hardening gages of this kind, the strains are immediately relieved by heating the gage slightly. This is done by simply holding the gage for a short time close to the furnace, and then allowing it to cool in the air.

Use of Tin Shield for Gage Hardening

The diagrams *D*, *E*, and *F*, Fig. 6, illustrate a second method of hardening T-shaped limit gages when it is desired to harden them along the edges as indicated by the shaded area. A tin shield which fits closely against the central part of the gage on both sides is placed in the position illustrated at *E*. After the usual preheating the gage is placed in a lead bath with the shield in place, as illustrated at *F*. When thoroughly heated, the gage is quenched in the water and is allowed to cool until it is just below the sizzling point, after which it is quickly immersed in the oil bath. The shield prevents the central part of the gage from hardening.

Hardening Snap Gages

The snap gages which are made of machine steel are pack-hardened on the gaging ends or jaws only. The handle of the gage is covered with fireclay so that it will not become carburized. A temperature of 1700 or 1800 degrees F. is required for the carburizing process. After the gage ends have absorbed enough carbon, the pack-hardening box and the gages it contains should be allowed to cool considerably below the decalescence point before being heated again for hardening. Ordinarily, the pack-hardening boxes are allowed to stand over night. The jaws are next heated to about 1450 degrees F. by dipping them in a lead bath, after which they are

Fig. 10. Grinding Jaws of Snap Gage

Fig. 11. Grinding Profile Gage

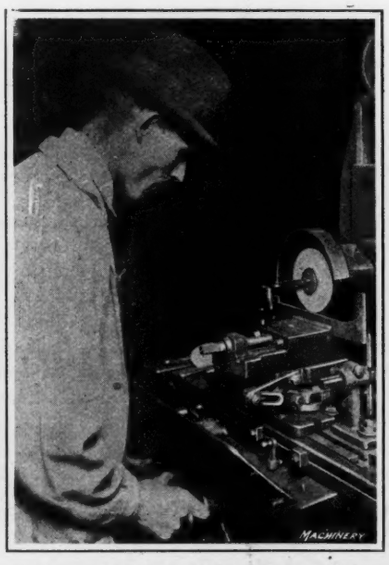


Fig. 12. Grinding Length and Contour Gage

Fig. 13. Lapping Thread Gages with Cast-iron Ring Laps in Lathe

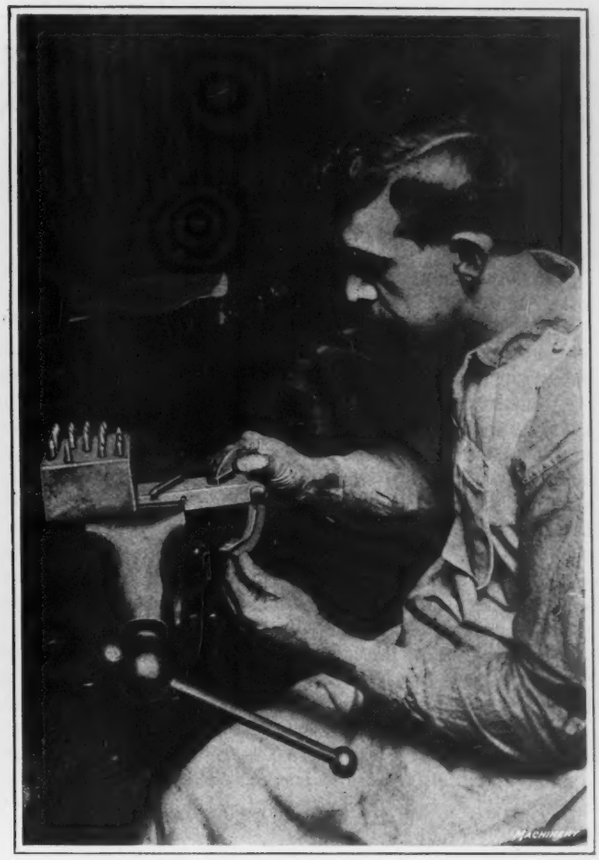


Fig. 14. Lapping Jaws of Snap Gage on Flat Cast-iron Lap

quenched in water. In order to toughen the jaws and prevent them from breaking off just back of the flat measuring surfaces, each side of the gage is partially submerged in the lead bath, as indicated in Fig. 9 so that the hardness of the gage is reduced at the weakest part of the gage section.

Grinding Hardened Gages

The methods of grinding gages at this plant are similar in many respects to those in common use. Fig. 10 illustrates the grinding of a snap gage. This gage is held in a vise attached to an angle-plate and a recessed wheel of the form ordinarily employed for such work is used. A 46J alundum wheel has proved satisfactory for this work. Fig. 11 illustrates how a gage for testing the profile of the shell nose is ground to the proper curvature. The gage is attached to a swiveling plate which is turned by the operator when grinding. This is simply a temporary fixture made for this particular operation. The grinding is done by the corner of the wheel, and this ground edge requires a little fitting afterward to make it conform to the male master gage which may be seen lying on the machine table. The master gage is ground on the same fixture, but the grinding is done by the periphery of the wheel and an accurate shape is obtained. Fig. 12 illustrates the grinding of one part of the gage used for testing the profile and length of the shell.

The thread gages are ground on a Hendey lathe provided with an attachment made by the International Equipment Co., Philadelphia, Pa. These gages are roughed out prior to hardening in another lathe to within about 0.008 or 0.010 inch of the finished size. The practice is to rough out the threads on a number of gages and then take the finishing cuts on all of them with a sharp tool in order to secure smooth, accurate work. The grinding attachment, which is illustrated in Fig. 15, has a wheel-spindle which may be swiveled for aligning the wheel with the helix angle of the thread. The wheel is trued to the angle of the thread by means of the truing attachment shown in Fig. 18. The bar carrying the diamond is set to the required angle, and after truing one side of the wheel with the diamond operating at the front, the position of the diamond-holder is reversed in the bar; the diamond then operates on the side of the wheel and at the rear so that the position of the bar is not changed. The thread gage has

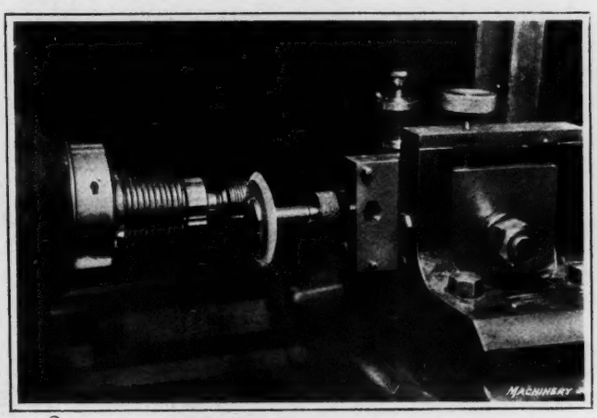


Fig. 15. Grinding Hardened Thread Gage on Lathe

Fig. 16. Testing Diameter of Thread Gage by Three-wire Method

a speed of about 12 feet per minute when grinding the thread, and the wheel has a surface speed of about 4300 feet per minute.

Lapping Thread and Snap Gages

The thread gages are lapped on the same lathe that does the grinding. The lapping operation is illustrated in Fig. 13. Four cast-iron split ring laps are used. These laps are split entirely through on one side and a screw is provided for adjustment. Three of these laps may be seen on the lathe and the fourth one is in use. The thread in lap No. 1 has an angle of about 59 degrees 40 minutes, the thread in laps Nos. 2 and 3 has an angle of 60 degrees, whereas the thread in lap No. 4 is slightly greater than 60 degrees. The exact method of using these laps depends upon the errors that must be corrected. When a lap is in use, a rod screwed into it is held with one hand while the other hand reverses the rotation of the spindle for screwing the lap on and off. The abrasive used for this lapping operation is a carborundum valve grinding compound, there being coarse and fine grades.

Fig. 14 illustrates the lapping of a snap gage. The flat cast-iron lap is held in a vise and the gage jaw is rubbed over it. The set of standards or end measuring gages used for testing the snap gages while lapping may be seen on the vise just back of the lap. About 0.0002 or 0.0003 inch is allowed for the lapping operation when the snap gages are ground.

Testing Accuracy of Thread Gages

The diameters of the thread gages are measured with ordinary thread micrometers while grinding and lapping, but the final test is made by the well-known three-wire method. The three wires are held together with rubber bands and the size over the wires is measured with a micrometer in the usual manner as indicated in Fig. 16. The apparatus for testing the pitch or lead of the thread gages is also shown in this illustration and in Fig. 17, which is a plan view. This device has centers for supporting the gage and a series of six test pieces or standards which may be seen just in front of the right-hand center support. The angles of the ends of these test pieces vary from 59 degrees to 60 degrees 30 minutes. On the standard having the smallest angle, one end is 59 degrees and the other 59 degrees 10 minutes. The angles on the other standards are as follows: 59 degrees 20 minutes, and 59 degrees 30 minutes; 59 degrees 40 minutes, and 59 degrees 45 minutes; 59 degrees 50 minutes, and 60 degrees 10 minutes; and, lastly, 60 degrees 20 minutes, and 60 degrees 30 minutes. The standard shown in use in Fig. 17, which has only a single V-shaped end, is made to a standard angle of 60 degrees. The gage to be tested and its arbor is held between centers, as the illustration shows, and one of the standards is placed against a shoulder at the left-hand side of the flat supporting surface. The gage is next adjusted by moving both centers axially until the end of the test piece exactly coincides with the thread groove, as indicated by a light test. One or more Johansson gage-blocks are then used to adjust the standard, say, one-half inch or whatever distance will bring it opposite another thread groove. The relative positions of the thread groove and standard then show whether the lead is accurate or inaccurate. A good light below the gage is desirable in order to make the errors clearly visible. The triangular shaped piece seen at the right of the standards on the base is used separately for testing the angle of the thread. The angles of the three points are 59 degrees 40 minutes, 60 degrees, and 60 degrees 20 minutes.

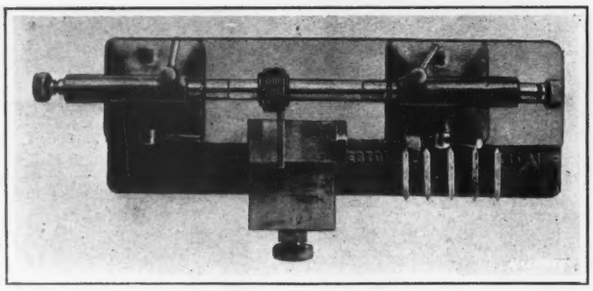


Fig. 17. Device used for testing Pitch and Inclination of Gage Thread

Marking Finished Gages

The size and number of each gage and the initials of the company are marked on the gage by means of the etchograph shown in use in Fig. 19. The gage or other part to be marked is held on a plate to which one of the leads or wires is attached. The marking pencil which is connected with the other lead consists of an insulated handle and a pointed copper wire which does the marking. As this point is moved along the surface of the gage the higher electrical resistance of the steel results in burning the surface and thus leaving a dark oxide mark. The two leads are taken from the secondary of a transformer which provides the required current and voltage. The amount of current and the depth of the marking is regulated by a rheostat controlling the amount of current delivered to the copper point or pencil.

* * *

Salt is a satisfactory flux in most cases of copper melting, particularly when tin and zinc are present. When the metal is thought to be badly deoxidized, a small amount of phosphor-copper may be used, but the phosphorus content must be kept so low that it will be absent from the finished metal.

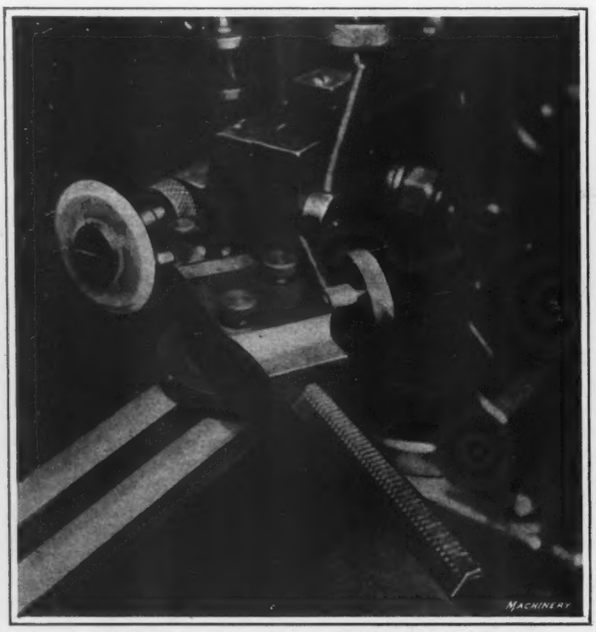


Fig. 18. Attachment for truing Wheel used for grinding Thread Gages

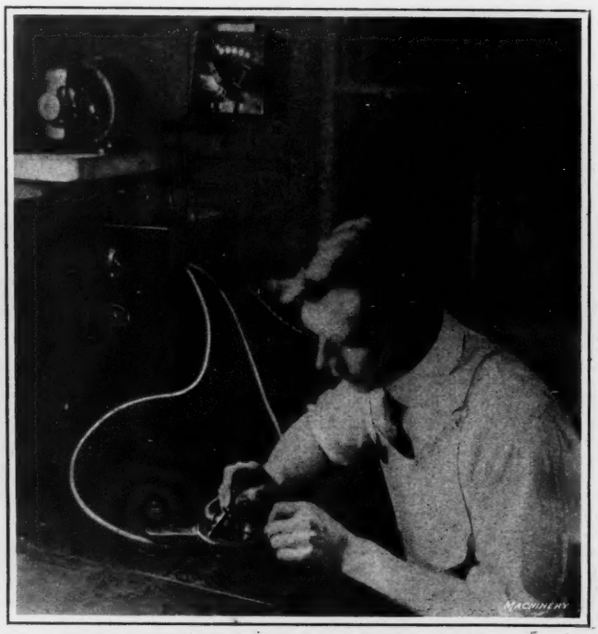


Fig. 19. Marking Size, etc., on Gage by Means of Etchograph

ENGINEERING SALESMANSHIP[1]

BY CHARLES W. HUNT[2]

The engineering salesman of the future should be something more than a mere canvasser seeking to introduce his firm's specialties to those who have never done business with the firm before. The salesman should be thoroughly familiar with the machinery he is selling. If he knows enough of the customer's requirements and the output or capacity of his own specialty, he will know whether or not his apparatus will fulfill the conditions required. It has been asserted that a salesman can make better progress in the selling of machinery which he does not know too much about, since his faith is not disturbed by an intimate knowledge of its shortcomings. This may have been true in the early days, but it is not now; indeed, the conditions are the reverse, and the more a salesman knows, the more he may be trusted to take care of himself. This knowledge of things would, of course, eliminate that kind of salesman who is out to sell anything to anybody, suitable or unsuitable for the work intended, and regardless of whether the goods will ever be paid for or not.

First Principle of Salesmanship

The most efficient factory organization, possessing ample appropriation of responsibility, can be stultified by indifferent or bad selling arrangements, and it is therefore all the more up to the salesman to take a special pride in making each sale a satisfactory transaction to both the customer and his firm. To insure this, he must see to it, as far as possible, that the best machine for the job has been selected at a price fair to both sides. He must leave no room for misunderstanding and dispute over mechanical details, date of delivery, terms of payment, erection and preliminary running of machine or machines, foundation plans, route or method of transport, etc.; and he should, as far as practicable, secure sufficient data to enable his firm to begin and complete its work without being compelled to ask the customers for additional information. More disputes between manufacturers and their customers are due to lack of precision and thoroughness on the part of the salesman, possibly, than from any other cause, and the responsibility for many disagreements can be traced to this source.

In the majority of cases it is the salesman, and the salesman alone, who is in touch with his customer's requirements; and possibly it is he alone, especially so when abroad, who sees the machine or machines at work after delivery. So it is he, too, who must face the music if anything goes wrong, if this contingency arises, and it not infrequently does through all sorts of causes; sometimes through ignorance or stupidity in the first handling of newly installed machinery, sometimes through the opposition of workmen, as well as occasionally through the desire of the purchaser to be rid of his bargain because of changed conditions, or, perhaps, because the machinery does not fulfill its guarantee, or come up to expectations. Whatever the cause, it is then that the salesman with his shop practice as a trained engineer comes in; and the more he knows about the processes of manufacture and the machine shop operations, the better he is able to put intelligent ideas and suggestions before his customer and his principals, with a view of obviating future troubles, further advancing the business, or restoring confidence, and, it is hoped, adding to his own prestige and profits.

Qualifications of a Good Engineering Salesman

If the true art of salesmanship consists in marketing goods at a profit in such a way as to insure satisfactory dealings with the customer, it is difficult to overestimate the mercantile value of good selling faculties possessed by a commercial engineer to an up-to-date progressive and modern engineering business, which may be summed up as follows:

1. An accurate conception of purchaser's requirements, together with ability to sell at a profit.
2. An intimate knowledge of the machinery being offered, backed by confidence in the disposal thereof.
3. A wide acquaintance and close knowledge of the district being operated in.
4. Ability to render satisfaction to customers and the firm.

Importance of Personality in Engineering Salesman

In addition to mechanical and commercial knowledge, it is important that the engineering salesman possess that indefinable quality called personality. Whether this is acquirable or not, it is impossible to say, just as it is equally difficult to describe. But it is a factor which counts for greatness, and it is certain that no success can be hoped for without it. A lack of personality can sometimes be substituted by a good manner and pleasing demeanor, and these may well stand in its stead temporarily. Personality, however, is a tremendous factor in the sale of products requiring engineering and technical knowledge, and it can be cultivated and deepened. Success often hangs on that one feature, and the man endowed with integrity, honesty of purpose, wide cultivation and balancing power, combined with abundance of energy, will doubtless become a most successful engineering salesman, while men of dull temperament ought not to take up this calling, wherein personal magnetism counts for so much.

General business honesty is an essential qualification for an efficient and successful salesman. Some salesmen seem to think that a possible trick is justifiable so long as one gets the order. This policy might succeed if there were a new customer for every deal, but in engineering, the salesman has not only to make a customer, but to retain him permanently. At all times, therefore, the deal one is seeking to negotiate must be clearly and transparently to your client's advantage to acquire, and facts and figures should be at hand to support this contention. It is by far the best plan to obtain orders that are likely to bring repeat orders or recommendation.

Resourcefulness

A further faculty to be developed is resourcefulness. In the progress of a negotiation of any size, the setting is likely to change between its inception and its close, and it is necessary that the salesman should be able to size it up quickly and change his tactics. Resourcefulness will enable him to know when to pursue the policy he has been following and when to alter it. He must be quick to adapt himself to any circumstances which may arise throughout the negotiations. Hence, he must have a quick, instinctive knowledge of character—and sometimes must be a thought reader as well—so that he can discern and understand his client or potential customer almost at sight.

Investigation of Complaints

An important part of the duty of an engineering salesman calling for tact, insight, and diplomacy, is that connected with complaints. Occasionally, through causes over which one has no control—carelessness of workmen, indifferent packing, damage in transit, and many others, some of which have already been referred to—a machine, or it may be an installation of machinery, does not come up to the expectations or is not satisfactory to the purchaser, and payment is probably withheld. Complaints are raised which may be serious or otherwise, according to the nature and degree of the trouble. Of course, the salesman who has engineered the deal comes in for an early share of the "complimentary" things which are being said, and naturally he is first called upon to face the matter.

It is not humanly possible, of course, to lay down rules, however broad, that would adequately cover or even be specific for the whole field of complaints pertaining to or arising out of the troubles and shortcomings of mechanical devices, which are so extremely variable, and at the same time so irksome and annoying, as everyone who has ever had any experience at all must have discovered. Perhaps, however, there are one or two points which may be put forth as a guide:

Don't pretend, first of all, to have sized up all the trouble right away and begin to blame everybody but yourself, but rather endeavor to understand it thoroughly from your customer's point of view.

To do this properly, give every consideration and attention to his views of the case; be sympathetic and patient, offer

[1]Abstract of a paper read before the Manchester Association of Engineers.
[2]Care of Selson Engineering Co., Ltd., London, England.

sensible advice or suggestion as far as the situation will allow, and prevail upon your firm, if need be, to do likewise.

Inside Support

An engineering salesman should always be well backed up by his firm: by advertising, by the distribution of well-arranged catalogues and well-printed literature, lists and pamphlets, in which all dimensions, weights, and prices should be clearly tabulated and set forth—those for foreign countries being printed in the language, units, and prices of that country—and, of course, he should be assisted from time to time by well-illustrated articles in the technical press and magazines, both at home and abroad.

When the selling side of an engineering business is properly attended to, it is not alone the salesman that counts. Naturally there must be behind him an organization which can effectively attend to the commercial correspondence and estimating side of the business, of which, after all, the salesman is only a part.

Post-war Conditions

When the war is over, there will be a wide field for the engineer salesman, larger and wider, perhaps, than ever before. Not only will the manufacturers have to be prepared to quickly switch off making munitions of war, and promptly go on with the regular productions of the requirements of peace, and those things which belong to the vocations of peace, but they will have to cater for it differently from what they have ever done before; and their commercial side will require a great deal of overhauling and reconstruction if they are to take advantage of the sacrifices of the war, and of the lessons which other nations have taught us.

With all these forces at work helping to prepare for post-war conditions, is it too much to hope that our banks and financial houses will then grant increased and better facilities, so that by the establishment of trade banks for domestic as well as for foreign trade, we may find ourselves when the war is over in at least as good a position as the Germans with their Cartel System, which, as everybody knows, was so largely responsible for their great commercial prosperity during the years immediately preceding 1914.

* * *

THE FOURTH LIBERTY LOAN

Toward the end of this month, the Government of the United States will call upon the men and the women of the country to support a new great loan to aid in the winning of the war—the Fourth Liberty Loan. The issue of bonds for this loan will equal or exceed $6,000,000,000. The tentative date for the opening sale of the new bonds is September 28, and the campaign, it is expected, will continue for about three weeks.

To successfully carry on the war, it will be necessary for us as a nation to spend $24,000,000,000 during the fiscal year ending June 30, 1919. This money will be raised in two ways: by taxation and by the issue of bonds. During the past year, when the total expenses of the Government amounted to about $12,000,000,000, taxes of all kinds produced about one-third of this amount. It is contemplated to increase the revenue from taxes in somewhat the same ratio during the coming year, plans being now under way to make substantial additions to the amounts derived from war profits and personal incomes. Even if these additions should increase the tax returns to $8,000,000,000, there is still $16,000,000,000 left to be raised by bond issues. This makes it necessary for everyone to subscribe for bonds to the limit of his or her ability.

It is to be hoped, and there are reasons for believing, that the Fourth Liberty Loan may also prove to be the Victory Loan. There are now 1,500,000 United States soldiers in France. Several hundred thousand are landing every month, and the way in which the Army of the United States held its own and defeated the Germans during the July drive, together with the successes of the French and the British, is a sure sign, so military experts tell us, that the fortunes of war have swung our way.

The workers in the industries of the country will play a more important part than ever in the raising of the Fourth Liberty Loan. While the cost of living has increased, it is a fact that, in many cases, in industrial work, the increases in wages have been proportionately greater than the advanced cost of living, so that the industrial workers are actually in better circumstances now than previous to the war, and, hence, are better able to aid the Government by financial assistance through the buying of Liberty Bonds. That every American will do his share is beyond question.

In determining upon the amount that each should subscribe, it should be borne in mind that if the Government calls for $6,000,000,000, the average subscription as compared with the Third Loan must be nearly doubled; hence, everyone should consider it his duty, if it is at all possible, to make his subscription for the Fourth Loan double that for the Third Loan. In this way only will it be possible for the Government to raise the enormous sum required. Remember, this is not the Government's war, it is our war—yours and mine.

* * *

ADVANTAGES OBTAINED BY HAVING A NATIONAL TRADE-MARK

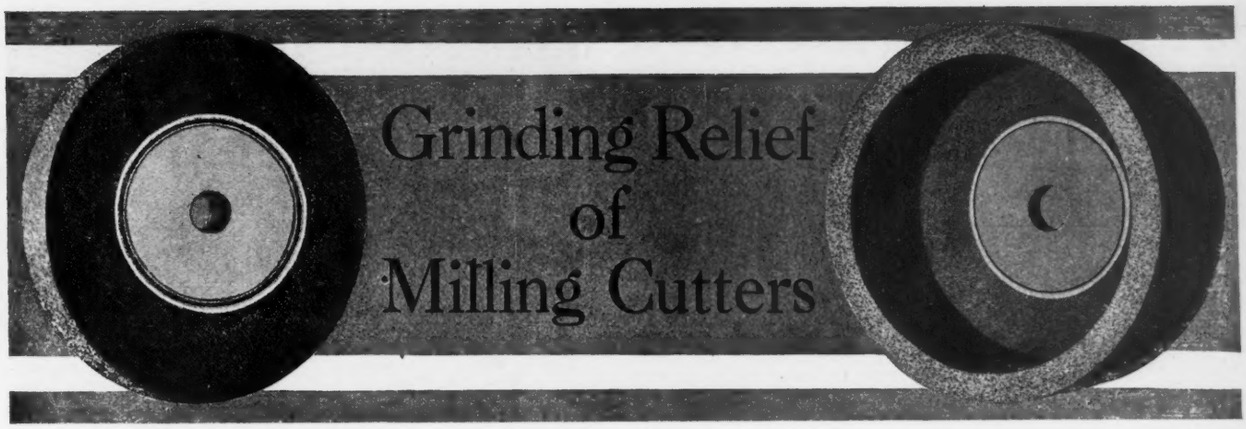
The proposal of the Department of Commerce to create a National trade-mark has been heartily endorsed throughout the country. Opposition, however, has been voiced by the owners of trade-marks that by reason of extensive advertising and high standards of merchandise have become favorably known in foreign markets. These firms claim that a national trade-mark will enable their domestic competitors to accomplish easily what they have done only by years of effort and at considerable expense. It should be remembered, however, that because a competitor can place the national trade-mark on his products this will not enable him to build up a big foreign business without expense and effort. While a certain amount of good-will will attach to his goods as a result of their bearing the national trade-mark, he must develop a merchandising organization to sell his goods abroad, must overcome the problems of transportation, credits, agencies, styles, correspondence in foreign languages, duties, packing, etc. When he has accomplished all this, if his goods find a market abroad, it will not be at the expense of the established manufacturer unless the product is more meritorious. Besides, a national trade-mark will be of great benefit to the established owners, for by means of this national mark, he will be able to identify his goods as having been made in this country, for this mark cannot be freely used by foreign competitors as can the legend "Made in the U. S. A."

The established owner of a trade-mark will also be benefited by the creation of a national trade-mark by helping to create good-will in foreign markets for products bearing the national mark. In this way he helps to increase the country's foreign trade and the popularity of American goods abroad to a point where shear bulk of foreign trade creates credit, transportation, and other facilities that are so helpful in carrying on a profitable foreign business. Another benefit to the established manufacturer, is the fact that only reliable manufacturers will be able to use the national trade-mark, thus forestalling boycotts of American goods that sometimes follow the shipment of dishonest goods bearing the uncontrolled legend, "Made in the U. S. A," with the result that the foreign buyer will no longer be satisfied with a mere statement of origin. The established manufacturer will also benefit in domestic trade, for the national trade-mark is likely to be a great selling force.

It has been asserted that such a national mark will be applied to all sorts of products, good, bad and indifferent, but the bill now pending provides for the forfeiting of a bond of $5000, as well as revocation of the license, where the licensee does not faithfully comply with the regulations governing the use of the mark.

* * *

It is stated in the *Iron Age* that the American Brass Co., which is one of the largest producers of the familiar alloy of nickel, copper, and zinc, generally known as "German silver," has changed the name of this product to "nickel silver," and that there is a movement on foot to abolish generally the designation "German silver."



Grinding Relief of Milling Cutters

A Comparison of Use of Disk Wheels and Cup-wheels for Grinding Milling Cutters and an Analysis of Results Obtained

At the present time there are two methods of relieving milling cutters in general use in the different shops throughout the country. Unfortunately, the cup-wheel, primarily designed and developed to grind and sharpen reamers, is still commonly used for similar operations on milling cutters. While the use of this type of wheel in relieving milling cutters theoretically possesses certain advantages over the disk type of wheel, actual results have proved that longer life and higher rates of production are obtained with cutters relieved with the disk wheel.

About three years ago some tests were made as to the relative merits of milling cutters relieved with the cup-wheel, which gives a flat relief, and those relieved with the disk wheel, which gives a slight concave relief. The conditions under which each cutter was tested were exactly the same even to the point of using steel for the cutters from the same bar. The heat and hardening treatment was exactly the same on all the cutters, and the same milling machine was used in all the tests. These tests proved that, regardless of what combination of speeds and feeds were used, the result was practically always in favor of the cutter relieved with the disk wheel. In nearly all cases, 19 to 30 per cent longer service in inches being milled was obtained with cutters relieved with the disk wheel; although, in one case, a cutter relieved with a cup-wheel stood up slightly longer (2.7 per cent), but in this case both the cutters stood up such a short time and the speed and feed used were so abnormal that this could hardly be called a practical test. The speed in this case was 238.4 feet per minute and the feed was 6¼ inches per minute. In all tests, special annealed tool steel of 1.02 per cent carbon was used. Tool steel, instead of a low-carbon steel, was selected so as not to waste an undue amount of time in conducting the tests.

The emery wheels used in relieving the cutters, which proved to be of the correct grade and grain, were Norton 38-36-I silicate alundum for the disk wheel and Norton 38-46-J alundum for the cup-wheel (Brown & Sharpe No. 50 shape). Great care was exercised in relieving the cutters so as not to burn the cutting edges with either wheel. It has often been claimed that the cutter relieved with a disk wheel is inferior to the cutter relieved with the cup-wheel, owing to the smaller amount of metal directly back of the cutting edge. Fig. 1 shows at *A* the manner in which a 12-inch disk wheel is used to relieve a coarse-tooth milling cutter 6 inches in diameter, having 14 teeth, a clearance angle of 7 degrees, and a width of land of 3/32 inch; at *B* is shown an enlarged outline of a tooth which has been relieved. It will be noted that the greatest depth of concavity amounts to only 0.00018 inch, and if the width of land is reduced to 3/64 inch, the greatest depth of concavity will amount to only 0.00006 inch. At *C* is shown a fine-tooth milling cutter, 6 inches in diameter, having 30 teeth, a clearance angle of 7 degrees, and a width of land of 3/32 inch ground with a disk wheel, 6 inches in diameter. For grinding a 5-degree clearance, a 7-inch wheel may be used instead of a 6-inch grinding wheel without interfering with the adjacent tooth. At *D* is shown an enlarged outline of a tooth which has been relieved with the 6-inch disk wheel. In this case a concavity of 0.00009 inch is produced, and from this it will be readily seen that the amount of concavity (which decreases with a smaller width of land) is practically negligible.

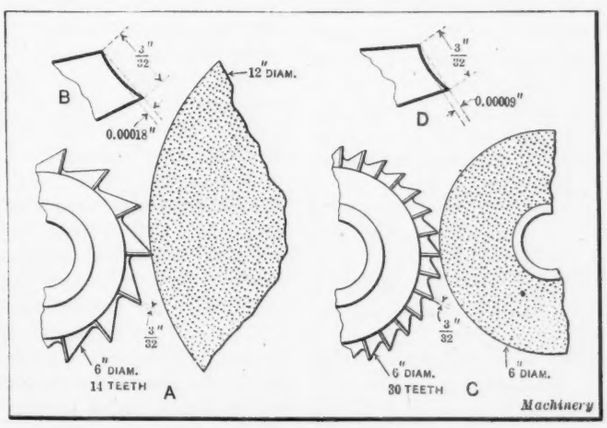


Fig. 1. Relieving Large-diameter Milling Cutters with Disk Wheel

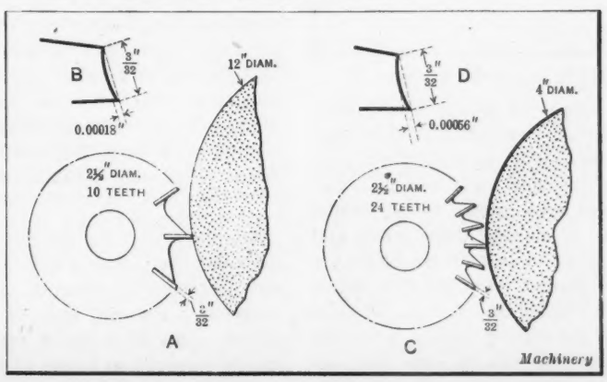


Fig. 2. Relieving Small-diameter Milling Cutters with Disk Wheel

In Fig. 2, at *A* is shown an example of the relieving of a small-diameter cutter, and at *B* is shown an enlarged outline of the tooth relieved with the disk wheel shown. At *C* and *D* are shown in a similar way the effect of relieving a small-diameter, fine-tooth cutter with a disk wheel. In all cases, it will be seen that the actual concavity produced by relieving with the proper sized disk wheels is so small as to be practically negligible. While the old fine-tooth cutters illustrated are little used at the present time except for special purposes, they are given to show that even when the diameter of the emery wheel is limited, satisfactory results can be obtained by relieving with a disk wheel. In relieving coarse-tooth or heavy-duty cutters, it will be found that the diameter of wheel which can be used is practically unlimited, and when grinding these cutters, one is only de-

pendent upon the largest diameter wheel which can be used on the grinding machine. Cutter grinders in general use, however, take a maximum diameter wheel of 7 inches; but as large a wheel as the grinding machine will conveniently take without interfering with the adjacent tooth of the cutter should always be used, as such a wheel produces the least amount of concavity.

On page 1092 of MACHINERY'S HANDBOOK is a table which gives the distance to set the center of the grinding wheel below the cutter center to give clearance angles of 5 or 7 degrees when using disk grinding wheels of from 2 to 7 inches in diameter. A table is also provided which gives dimensions for use in setting grinders for relieving with cup-wheels.

The following shows the probable reasons why the disk-wheel relieved cutter proved to be superior to those relieved with cup-wheels. It will be readily seen that a cup-wheel, even

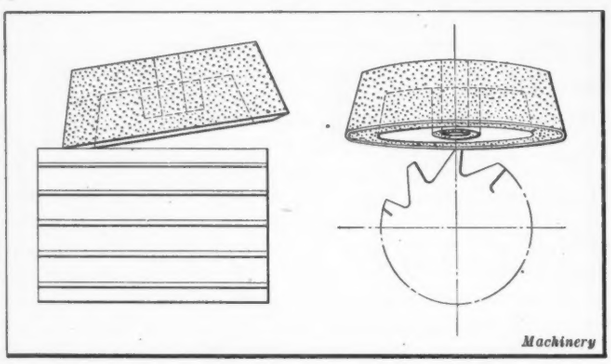


Fig. 3. Correct Method of relieving Cutter with Cup-wheel

when used correctly, as shown in Fig. 3, will, owing to the large contact surface, have a tendency to burn the outermost cutting edges of the cutter. This burning of the cutting edges is more difficult to prevent when grinding in the manner shown in Fig. 4. This method is, of course, incorrect and one that should never be used except in cases where it is impossible to employ the method shown in Fig. 3. The writer would say, however, that the cup-wheel is the correct one to use when grinding the side teeth of a side or straddle milling cutter, the straight side of an angular cutter, or any cutter where the side teeth do no actual cutting but serve as chip space.

The cup-wheel, owing to the large contact surface with the cutter teeth while grinding, will produce a glazed surface on the teeth, which, in combination with the burnt extreme cutting edges, produces even in a new cutter an edge which becomes dull very quickly. It has been said that high-speed

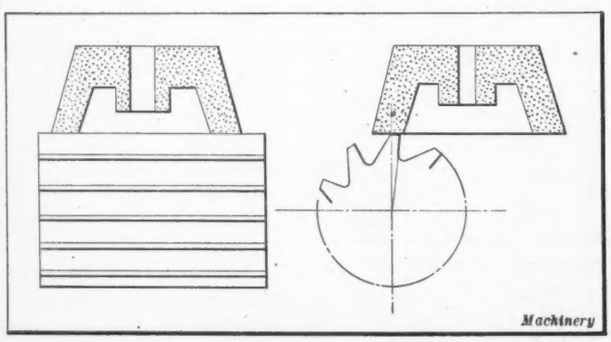


Fig. 4. Incorrect Method of relieving Cutter with Cup-wheel

steel cutters never maintain an extremely sharp cutting edge, and that they lose their edge after the first few cuts have been taken. While this may have been true of high-speed steel cutters that were first placed on the market, it will be found that during recent years high-speed steel cutters do not possess this defect, due to new methods in making these steels and more knowledge in heat-treating them. The main reason for the longer service given by cutters relieved with the disk wheel will be apparent by referring to Figs. 5 and 6. In Fig. 5 is shown a highly magnified view of the cutting edge of a milling cutter relieved with a disk wheel. It will be seen that the small grooves are non-uniform in width and depth, which is

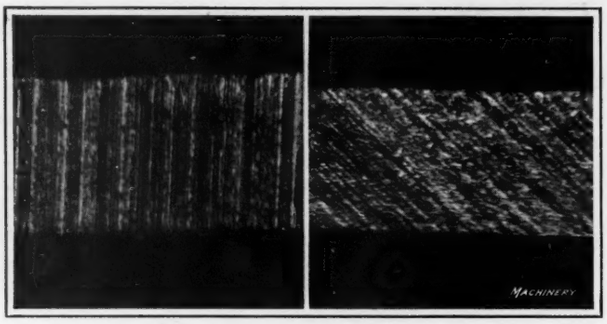


Fig. 5. Enlarged View of Cutting Edge of Milling Cutter relieved with Disk Wheel

Fig. 6. Enlarged View of Cutting Edge of Milling Cutter relieved with Cup-wheel

one of the principal advantages. These grooves have a tendency to break up the chips in much the same way as does the nicked tooth milling cutter. Thus less heat is generated, which results in longer life and superior wearing qualities in the cutter. The minute grooves do not, however, affect the smoothness of the finished cut, as the grooves are not uniform, a groove in one tooth being compensated for by a ridge in a succeeding tooth. In Fig. 6 is shown the ground surface of a cutter relieved with a cup-wheel. As will be seen, the minute grooves are uniform, and, in this case, run diagonally across the face of the cutting edge and show a much smoother, "glazed" surface than the tooth relieved with the disk wheel.

If a cutter is worn down so as to have the lands unusually wide, it would be advisable to use a cup-wheel first, as shown in Fig. 7. After the teeth have been ground down to the required width of land, a disk wheel can be used to relieve them in the usual way.

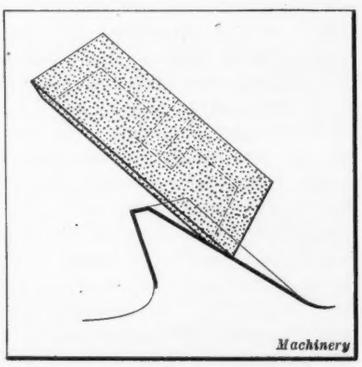


Fig. 7. Correct Method of using Cup-wheel to reduce Width of Land of Milling Cutter Teeth Previous to sharpening

* * *

The majority of the reported cases of boiler bagging are due to the presence of scale or oil in the boiler. The removal of the former may be accomplished by what has been termed the "periodical clean" method—that is to say, by the use of mechanical cleaning methods each time the boiler is opened for inspection, by the introduction of boiler compounds, or by treating the feed-water chemically. No amount of chemical treatment will remove oil from feed-water, however, and some mechanical filtering process must be relied upon for its elimination. Some engineers favor cloth filters and some sawdust, sand, or other substances; the design of the filter itself however, is of the greatest importance, and individual manufacturers of these apparatus may be relied upon to adopt the filtering medium which is best suited to their own construction. With regard to the comparative harmful properties of various oils, the most dangerous bags are generally caused by animal and vegetable compounds, with or without the additional presence of scale. Attempts to boil them out with soda or some alkali are to be severely condemned as rendering the oils more dangerous still. As has been stated no amount of boiler compound can counteract the ill effects of oil entrained in feed-water, it being imperative that some external mechanical means be adopted when it is present.

* * *

An alloy that resists hot concentrated sulphuric acid remarkably well, and which, therefore, may be assumed to resist corrosion in general, is composed of about 4 per cent tungsten, 2 per cent iron, 44 per cent copper, and 50 per cent nickel. This alloy has a very high electric resistance and a tensile strength of about 60,000 pounds per square inch. Another advantage is that it can be easily machined.

HOW A MEDIUM-SIZED PLANT SOLVES ITS LABOR PROBLEMS

BY H. E. SLOAN

Superintendent, Cushman Chuck Co., Hartford, Conn.

IN view of the difficulties that a great many manufacturers have had in retaining their old force of machinists and toolmakers and in hiring and training new men, the experience of the Cushman Chuck Co. in handling its labor problem may be of interest to employers generally, and an attempt is made in the following paragraphs to point out a few of the underlying principles that have been observed by the management of the Cushman Chuck Co. in handling the situation so as to avoid the difficulties, with regard to the labor supply, which appear to have been the stumbling-blocks of a great many other manufacturing plants, especially those of small or medium size.

It is not proposed to state definitely that every manufacturing plant could have solved its labor difficulties in the same way as has the Cushman Chuck Co., because, of course, different plants face different conditions, but it is believed that a recognition and adherence to the underlying principles outlined in the following would minimize the difficulties in most cases. The first essential is a correct attitude of the employer toward labor, which, in most cases, will bring forth a proper attitude of labor toward the employer.

Proper Working Conditions

In order to keep the old force of men and to attract desirable skilled labor, it is necessary first to provide proper working conditions. A light and clean shop is just as important in attracting and holding the best class of labor as are reasonable wages, because the best class of men object to working in dark and dirty shops where little or nothing is done for their personal comfort. Hence, the first requirement is to provide a light, clean, neat, properly ventilated, and properly heated shop.

Hourly Wages and Bonus Payments

The Cushman Chuck Co. has never adopted any of the modern piece-rate systems, although at one time it paid a bonus, which has since been discontinued. It has been found that with a desirable class of labor such as is attracted by good working conditions, it is possible to obtain conscientious men who will perform their duties when paid a proper hourly wage. At least, this has been found to be the case in the plant under consideration, employing from 250 to 300 men. In very large plants, possibly the conditions are different, but the present article deals primarily with the medium-sized manufacturing plant.

It is the belief of the management that the payment of a certain additional percentage of a man's wages in the form of a bonus is not as attractive a form of compensation to the best grade of labor as is a higher hourly rate. If, in the cases where the bonus system is applied, a man is worth his hourly rate plus a bonus, he is also worth an hourly rate high enough to include the bonus from the beginning. This appears to have been recognized by other manufacturers as well, as recently some large manufacturing plants have discontinued the payment of bonuses in the form of a percentage on total earnings and have returned to straight hourly or piece-work rates.

Another principle that has been applied with satisfactory results is to pay the men who have been a long time in the company's employ a higher rate than new men who have just been hired. This shows the older men that the company appreciates their services and places a premium upon steady employment with one firm. This principle is also perfectly equitable, because even though the new men may perform practically the same work as the older employe, the latter is, however, more valuable to the firm, partly because he is familiar with its policies and the class of work being done, and partly because of the assurance that the firm has that this man will remain with them. It costs a great deal to hire new men, train them, and have them leave your employ. Hence, the man who stays steadily on his job is worth a higher hourly rate, and this condition should be generally recognized. If it were, men would hesitate before leaving one job in order to take another.

Train Men in Your Own Shop

The Cushman Chuck Co. has always believed in training its own men as far as possible. As a result, at the present time, the superintendent of the shop, all the foremen, and more than one-half of the number of toolmakers employed are men who have received their entire shop training in the company's plant. A great many of the machinists have also been trained in the shop, and the fact that they have remained with the company for years indicates that the principles laid down in the foregoing as to means for holding a desirable class of labor are correct. It is also worthy of notice that during recent years a number of large firms have recognized the necessity of training their own men with a view to obtaining a permanent staff of executives and workers and prevent the constant changing of the personnel of the plant.

American Citizenship Desirable in Employes

It is desirable that the employes be American citizens as far as possible. This does not mean that they may not be born in a foreign country, but it means that the best men are those who affiliate themselves with America after their arrival in this country and who become citizens of the United States as soon as they are permitted to do so under the laws of the country. It is interesting to note that the nationalities that generally have been considered the most satisfactory as employes in machine-building plants are also the ones that most generally become citizens. A census was made of all the employes of the Cushman Chuck Co. and it was found that, while a good share of all of foreign birth were citizens, everyone of those of Scandinavian and Irish extraction were citizens. It is believed that employers could do a great deal toward furthering the Americanization of their workmen by encouraging those who already have become citizens of their own volition to induce others of foreign birth to do likewise. It is easier for one man of foreign extraction to broach the subject in a forceful way to another man than it is for the employer to do so, as his motives may sometimes be misinterpreted.

* * *

HEALTH OF INDUSTRIAL WORKERS

The National Industrial Conference Board, composed of representatives of seventeen national industrial associations of the United States, has issued a strong appeal for a national policy aiming at the prevention of sickness, so far as possible, by action of the Federal Government, pointing out the advantages of preventive measures over insurance against sickness. Various statistics are quoted showing the nature of the problem, and the need of some action being taken to improve the health of the community. Of 2,500,000 men examined for the National Army in 1917, 33 per cent were found physically unfit and were rejected. At the National Conference on Industrial Diseases held in Chicago in 1910, it was estimated that 284,750,000 days were lost through sickness in a year by the 33,500,000 men, women and children then engaged in gainful occupations in the United States, an average of eight and one-half days per worker. This is in agreement with the results of sickness surveys made by the Metropolitan Life Insurance Co. among policy-holders and others in various localities. If these surveys hold for the industrial population of the entire country, it is estimated that the present annual wage loss for 40,000,000 workers from sickness may be conservatively placed at from $500,000,000 to $750,000,000. A further industrial loss is due to the impairment of the efficiency of a large proportion of workers through various physical defects and ailments. Nothing that the Federal Government could do with regard to industrial conditions is of greater importance than the question of the prevention of sickness due to preventable causes.

FUSION WELDING FALLACIES—3

SOME COMMON BELIEFS AND WHY THEY ARE UNSOUND

BY S. W. MILLER[1]

Fig. 17. Weld made in Narrow V

IN the July and August numbers of MACHINERY, several commonly accepted but erroneous opinions about fusion welding were dealt with. Among other common fallacies are the following: That a V with an angle less than 90 degrees may be safely and economically used; that low-carbon steel can be burnt with a neutral flame; that a ripple weld is a good weld; that a narrow weld is a good weld; that those in authority can leave to the judgment of subordinates matters involving the possibility of danger to life or property, or requiring scientific knowledge.

A V Should not have a Smaller Angle Than 90 Degrees

Although it has been repeatedly stated that a 90-degree V between the pieces welded is necessary, if good results are to be secured, some welders use a V with a smaller angle. As a result, defective welds, due to this cause, are common. It is impossible to make a sound weld unless the angle is close to 90 degrees, because of the high surface tension of the melted metal. The existence of surface tension may be proved by drawing a needle between the fingers to give it a slight coating of grease and then carefully laying it upon some water in a bowl; although the needle will float upon the water, the surface will be depressed by the weight of the needle at that point. It is the surface tension that makes the drops of liquids, including melted metals, round, because its power must be equal in all directions.

The surface tension of the melted metal tends to make the metal hang above the bottom of the V, as shown at *A*, Fig. 18, if the weld is not made entirely through the bottom of the V, which will result in imperfect work. If the bottom of the V is burnt through, as shown at *B*, the V will be too narrow and the metal will tend to form a bridge, as shown at *C*, as the bottom edges of the vertical sides cannot be reached by the torch to melt them together. It is then necessary to burn down the sides and through the bottom of the V, as shown at *D*, thus leaving a wide opening which must be filled at a large expenditure of labor and gases. On the other hand, if a wide V is made, as shown at *E*, the bottom edges can be fused together and even allowed to fall a little below the bottom surface, as shown at *F*. The surface tension this time is an advantage, as it prevents the metal from going too far if properly handled. Then still more metal should be melted down from the sides of the V, as shown at *G*, so that the top will become wider and the bottom will have the shape of a shallow cup. The welding can then be proceeded with in the usual way. It is not to be assumed, of course, that a wide weld is necessarily a good one; but a narrow one is invariably bad. Fig. 17 shows a weld made in a narrow V. The illustration shows clearly that the bottom part of the V is not welded on either side; the welding rod has simply been melted into the opening.

Low-carbon Steel Cannot be Burnt with a Neutral Flame

Burning of steel may mean one of two things. When the term is used by blacksmiths and metallurgists, it means that the steel has been overheated and has become brittle or, rather, crumbly when hot, and brittle when cold, due to a mechanical separation of the grains. This has been stated by Professor Howe as follows: "But if the overheating is extreme, then the cohesion between the adjacent grains becomes so feeble that they are forced apart to a certain extent by gas evolved from within. This gas probably consists, at least in part, of carbonic oxide, formed by the union of the infiltering atmospheric oxygen with the carbon of steel; such steel is said to be 'burnt' as distinguished from that which is simply overheated; and we may provisionally adopt this distinction, that burning consists in a mechanical separation of the grains on extreme overheating. Burnt steel is recognized by its extreme brittleness, both hot and cold, its coarse, shining fracture, and the oxide coating which we often find in that fracture."

Burnt steel can usually be readily identified, as a low magnification shows that it contains cracks. The burning does not take place where the steel is melted, but occurs next to the fused part; that is, close to the welding line in a weld made in high-carbon steel. It is for this reason that high-carbon steel cannot be welded. While the weld may be all right, damage to the original material next to the weld cannot be avoided, as there must be a zone where the heat conditions are just right to cause burning. For this reason a welded piece of such steel always breaks close to the weld. The other kind of burning is that which occurs in using a cutting torch. In this case, the steel is almost entirely converted into oxide, which is, of course, a genuine burning, similar to the burning of coal or wood.

The writer has never been able to detect the first kind of burning in low-carbon steel, either in the weld or in the original material, even when the weld is made with a strongly excess oxygen flame. Such a flame will make the welded metal boil and produce a large amount of slag in the form of a white foam, which will float to the surface if a large pool of melted metal is maintained. Of course, this is bad practice, not only because of the wasted metal, but because such a weld contains much more oxide, in the form of small dots, than a weld made with a neutral flame. Fig. 19 shows a weld made with a neutral flame that has been etched and magnified 150 diameters.

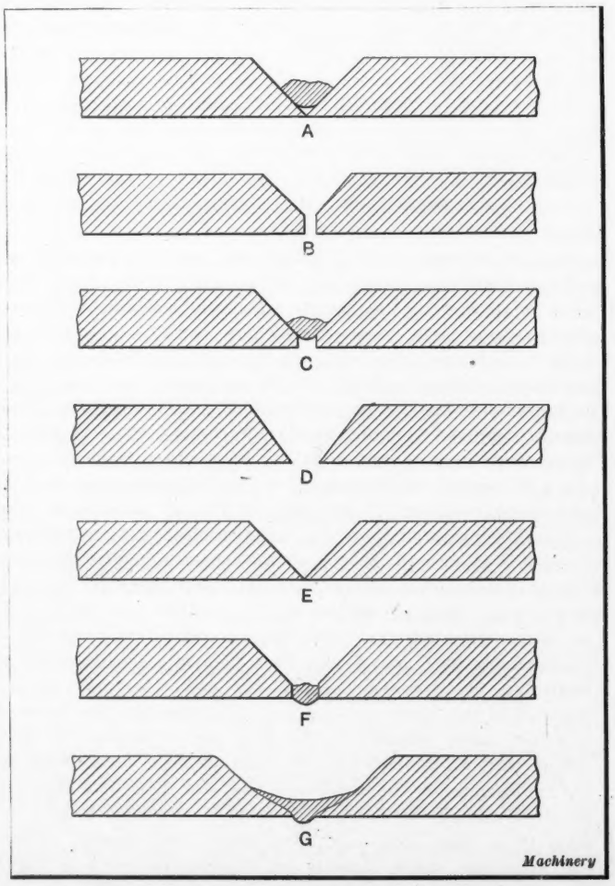


Fig. 18. Influence of V on Welding Results

[1]Address: Rochester Welding Works, Rochester, N. Y.

The weld shown in Fig. 20 was made with an excess oxygen flame and is magnified 315 diameters, but was unetched; the oxide appears as black dots and spots. In Fig. 21 is shown an electric weld that was made with a metallic electrode, etched, and magnified 315 diameters; the oxide appears as black dots. It is difficult to see what is taking place during the welding, and if care is not taken, large pieces of oxide will be enclosed in the weld. Care should, therefore, be exercised when using the term "burning," as the older, established meaning of the word is not applicable to the conditions existing in the welding of low-carbon steel.

A Ripple Weld is not Always a Good Weld

When done by an expert, a true ripple weld is a work of art. The ripples are uniform both in size and spacing and create the pleasing impression of a good job. These welds are usually seen at their best in thin steel, say sheets not over 1/8 inch thick, but in heavier sheets the writer has never seen a ripple weld that has gone entirely through. In material up to 1/16 inch thick, the necessary penetration can be obtained; but in sheets 1/8 or 3/16 inch thick, it is impossible to obtain a sound weld with a full ripple effect where metal has to be added. In light sheet welding, strength is usually a secondary matter and an imperfect weld may be good enough. In barrel welding machines it is necessary to weld from both the inside and the outside, the inside torch following the outside one and making a sound weld. The material used in this case is about 1/16 inch thick and no metal is added.

Fig. 19. Weld made with Neutral Flame; Magnification, 150

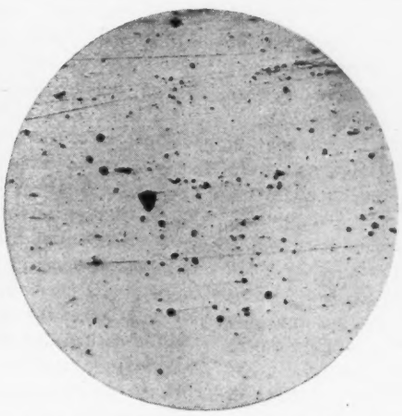


Fig. 20. Weld made with Excess Oxygen Flame; Magnification, about 315

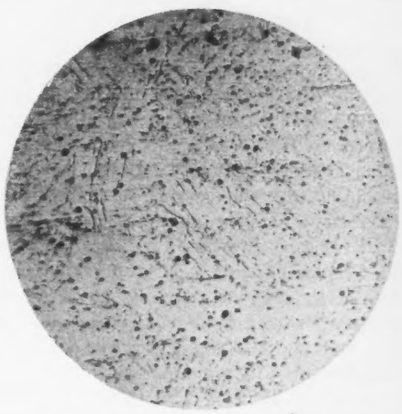


Fig. 21. Electric Weld made with Metallic Electrode; Magnification, about 315

A Narrow Weld is not a Good Weld

The writer does not believe it possible to make a narrow weld entirely through the sheet, and he has seen so many poor narrow welds, with never a good one, that he would condemn a narrow weld by outside inspection alone. By a narrow weld is meant one in which the width of the top of the weld is less than two and a half times the thickness of the sheet; and even this is less than is really safe, in the writer's opinion, and he prefers a ratio of three to one. When it is considered that with a 90-degree angle of the V the opening at the top is twice the plate thickness and that the plates should be a trifle apart, say 1/16 inch for plates 1/2 inch and more in thickness, it will readily appear that with a 1/2-inch sheet, the width of the top of the V, with a space of 1/16 inch at the bottom, will be 1 1/16 inch, which leaves only 3/32 inch on each side for melting down of the original, if the ratio of 2 1/2 to 1 is selected, which is little enough.

Questions Involving Possibility of Danger to Life or Property Should not be Decided by Subordinates

One of the real troubles in the welding industry is to find foremen who appreciate the problems involved, that is, men who can be made to feel that welding is more than a mechanical job. All kinds of men have been selected for this position and for all kinds of reasons. One superintendent may prefer a blacksmith because the blacksmith is familiar with steel and wrought iron, but he ignores the fact that the blacksmith knows nothing about cast iron, brass, aluminum, etc. The same line of reasoning may be applied in the case of any mechanic. Each trade finds its special knowledge useful in welding, and a first-class welder should know something about all metal trades. A welder who does only one thing may be trained quite easily in a short time, and he need not have much knowledge except how to do his special work correctly, but the man in charge of the work must know more than this. A person ignorant of the elementary practices of metallurgy and mechanics cannot be safely entrusted with welding work that involves possible damage to person and property, but a man who is otherwise competent and willing can be taught the necessary technical details. When those in authority fully realize their responsibility in this matter, proper methods of instruction, such as welding schools and trade journals, will come into their own, and expert metallurgists and engineers will not consider it beneath their dignity to be called into consultation when important welding work is being contemplated, planned, or actually executed.

It is also necessary for the expert metallurgist or engineer to realize the practical difficulties in welding. There is no mechanical process that appears so easy, and is in reality so difficult, as the successful handling of a torch. A great deal of loose talk is indulged in by salesmen of welding apparatus and other interested persons as to the ease of learning the work, and the uninitiated superintendent later wonders why his welders do not produce the desired results. A welder who has had considerable experience in training others said that superintendents and master mechanics frequently complain of the length of time required to train men for such easy work. His answer is to induce them to try the work, with the result that invariably, after a minute or so, they find some reason for going to another department; but they do not again complain of the lack of speed.

These facts have been stated not to make it appear that it is almost impossible to learn the art of welding, but to show that the principles of the art must be taught by metallurgists and engineers. The amount that should be taught any individual depends on conditions; but the principles must be developed in the laboratory and the work must be controlled by it in just the same way as the heat-treatment of alloy steels was developed and is handled.

* * *

Wrought-iron pipe may be distinguished from steel pipe by testing the material in the pipe for manganese, which is present in the steel pipe, but is not present, except possibly as a trace, in wrought iron. The following method for making the manganese test is given by Thomas F. Payne: Place a clean, bright chip or filing of the metal to be tested, about the size of a pin-head, in a porcelain crucible; add six drops of pure nitric acid, and heat; add two drops of silver nitrate solution, then one crystal of ammonium persulphate not greater than one-eighth inch in diameter; warm the solution, but do not let it boil. If the metal is steel, a pink color will begin to develop, and at this point the crucible should be removed from the source of heat, when a very decided red coloration will result. If no color develops, but a small amount of dark residue remains in the dish, the metal is wrought iron.

COMMERCIALIZING INVENTIONS

BY DONALD A. HAMPSON[1]

The last thing most inventors want is advice; generally they want money to exploit the invention or they want to sell it for a price usually out of all proportion to its value. But if an inventor would seek the advice of experienced men and apply it to the child of his brain, the money would be forthcoming in many cases. The engineer, the designer, the production man, the mechanic, are all qualified to offer suggestions as to the use, manufacture, and marketing of a newly invented article.

One of the inventors who is making money from his patents felt the need of a certain tool when doing some carpenter work. Finding that there was none on the market for this purpose, he tried to make one for his own use. Getting "stuck" on a matter of detail, he asked a carpenter's advice, who, seeing the utility of such a tool, made several suggestions, so that the tool, with slight additions, was made to serve still other purposes. The inventor had no idea of doing more than constructing a tool for his personal use, but out of curiosity inquired of a large jobber if such an article would sell. Learning that it would, he engaged a production engineer to outline equipment and operations for a small shop to do the work. That inventor started right. He knew he had an article that was practical and in demand; he knew he was not wasting money on fancy and useless construction, and he knew costs and selling prices. He has made a success of his invention.

Contrast this with the story of the ordinary inventor; for example, a man who invented an automobile horn in the days when all cars except three- and four-thousand-dollar ones were supplied with bulb horns. Klaxons sold for thirty dollars or more, and there was nothing to compete with the bulb horn, which everyone wanted to throw away. This man conceived the idea of a hand-operated ratchet wheel operating against a metal diaphragm, and secured a patent, with only a vague idea of the big field awaiting harvest. But he knew his horn would sell. He did his own designing and assembling, getting his parts from different machine shops to minimize the risk of anyone's stealing the idea. When the horn was in workable form and the patent allowed, he took it to a contract shop to negotiate for its manufacture. The shop's engineers knew the value of just such an article if it could be sold for between five and ten dollars, and outlined the tool cost, estimated the cost of manufacture, and redesigned certain details to eliminate costly, clumsy constructions. But the inventor flatly refused to listen to any changes, though they were offered with the idea of bettering the article and making money for the seller.

As a result, the horn went on the market with a heavy cast brass case that was expensive to finish and awkward in shape, instead of with the light steel stampings that are standard today. Besides, the inventor insisted that he should make a profit on the first five thousand, and into the cost of them he included all the experimental work and the tools for manufacture. Needless to say, such stubbornness delayed the work and made the price so high that the horns did not sell; in the meantime, other horns appeared on the market and made a handsome profit on a reasonably priced article.

Some of the men working on the samples of a new chain for automobile tires that had points of merit and was easier to attach than the conventional ones—men familiar with things patented and patentable—inquired if the new chain did not conflict with existing patents, but were told by the inventor that he knew what he was doing. A young draftsman who studied the trade papers informed the inventor at the beginning that any chain free to creep about the tire, such as his, was an infringement of the Weed patents and that suits were frequently brought and always were successful. But he was ignored, and the man continued to buy material and arrange a sales campaign; he even got a small plant going on the work. The injunction that followed resulted in his losing several thousand dollars.

Some men just cannot help inventing. To them every breakdown of a sausage grinder, every automobile trip, presents new opportunities for the application of their talents to the needs of mankind. But a few costly experiences make most of them receptive to suggestions when broaching the scheme to those whose business is the perfecting of inventions. A country doctor whom the writer once knew was one of these. When his car was stuck in the mud while on a country call, his active mind devised a false hub fitting over the hub of the rear wheel and clamped to it by clips around the spokes. The device included a wheel about seven inches in diameter that had spikes cast on the periphery for greater traction. Then when the rear end of the car was jacked up and a plank, suitably blocked up, was slipped under this spiked wheel, the power of the car would roll the machine right out of the mud onto the roadway. It never occurred to the doctor, until he took his wooden model to the shop, that anyone lucky enough to find a plank and get the car jacked up would be able to put the plank under the tire and run the car out without a special wheel on the hub. But when his attention was called to this, he saw the light at once and joined in the laugh.

Value of the Practical Man's Advice in the Development of an Invention

Summing up, men who plan and produce are far better qualified than a layman to say how a piece should and could be made, and they are universally ready to give others the benefit of their experience. A mechanical man designs and builds machinery and appliances for specific purposes; in so doing he produces apparatus and evolves processes that come under the generally accepted meaning of the term "inventions," but he disclaims all thought of being an inventor. Such work is his business and he thinks nothing of it. He is not jealous of the real inventor—he is ready to help. Contrary to an opinion often held, practical men are not aching for a chance to steal an invention. If they have had a broad experience, they know that it takes a sales organization to dispose of patented articles of merit; that it takes big money to create a demand for the best of untried new devices; that it takes engineering skill to reduce a device to manufacturing form, to select the most suitable materials, and to design tools that will turn out the goods without high-priced help.

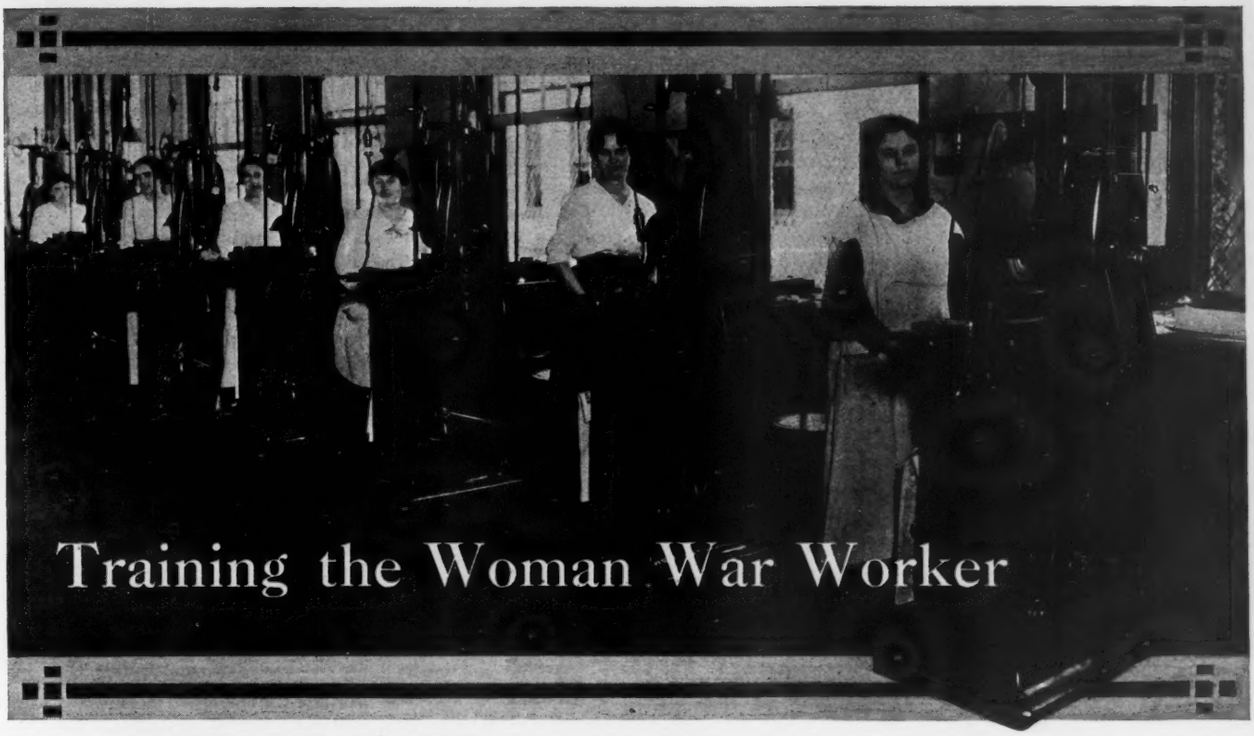
An article so made that it will not give a reasonable amount of wear or that cannot be sold for as little as the next best thing on the market is not likely to remain a "best seller" after the first season. The inventor needs the advice of the shop man—needs it as badly as the shop needs inventions to manufacture. An invention that cannot be commercialized is useless; so is one that can be and is not. A little more confidence in experienced men would raise the plane of inventors and fatten their bank accounts and put their ability in the rank of the professions.

* * *

SIMPLE ELECTRIC MOTOR REVERSING DEVICE

Electric motors are generally reversed by means of what is known as a pole-changing switch, which exchanges the connections of either the field magnet or the armature, but not both, for in that case the relative polarities would remain the same and the motor rotation would continue in its forward motion. The pole-changing switch requires six connections, two at the switch lever and one each at the four contacting points. An inventor working upon a device requiring extreme simplicity for reversing, as it was push-button controlled, made two separate windings for the field. One end of each winding is connected to a wire joined to one of the armature brushes, while the remaining two ends are connected to the terminals of their respective push-buttons. Pressing either button connects the circuit to the proper winding for the direction of rotation desired. In connecting the field terminals to the armature circuit and push-buttons, they are reversed to one another, so that the resulting magnetism is reversed. The buttons are mounted upon a rocker arm which prevents the operation of both at the same time. Push-button control can only, of course, be used on very small motors. The method can be used, however, on motors of any size by substituting a standard two-point switch for the buttons. H. E. D.

[1]Address: 31 Hanford St., Middletown, N. Y.



Training the Woman War Worker

Methods Used in the Plant of the Taft-Peirce Company, Woonsocket, R. I., in the Training of Women Machine Operators by Means of a "Vestibule" School

By Edward K. Hammond[1]

THERE are two general methods which have been followed by manufacturers in training women to take the place of men who have been drafted from machine shops for military service. One of these methods is to put the women to work in regular manufacturing departments of the factory as soon as they enter the company's employ, while the other is to have a training department in which the novices can learn to operate machines which are used especially for training inexperienced women employes. Both methods have their advocates and both will doubtless prove of interest to those readers of MACHINERY who are either engaged at the present time in developing women into machine tool operators or who anticipate the necessity of taking such a step if the draft makes further inroads into the number of men at present employed in their machine shops. In the April number of MACHINERY was published an article by Luther D. Burlingame entitled "War Work for Women," which described the results obtained by the Brown & Sharpe Mfg. Co., of Providence, R. I., in placing women in manufacturing departments of the plant as soon as they are employed.

It is the purpose of the present article to explain briefly the features of the system of training women which is used by the Taft-Peirce Mfg. Co., in Woonsocket, R. I., where the so-called "training room" or "vestibule" method is employed. This company has equipped a training room with five 16-inch Reed-Prentice engine lathes, five Brown & Sharpe hand screw machines (two No. 2, two No. 4, and one No. 6), and five Brown & Sharpe plain milling machines (four No. 1 and one No. 2). Women who are selected by the company's employment bureau are sent into this training room, where they get a little experience in the operation of any one of the three types of machine tools with which the training room is equipped. Regular commercial work is done, and it is aimed, as far as possible, to utilize all of the product of this schoolroom, but during the training period the women are given plenty of time to learn to manipulate the machines so that they do not become nervous and spoil pieces through an effort to keep up with the rate of production attained by experienced operators who would be employed near them in any of the regular departments in the factory. The length of time which a woman remains in the training room depends largely upon her previous training as well as her natural aptitude for mechanical work, but this period seldom exceeds two weeks, and it more frequently happens that a call is made upon the supervisor of the training room for an operator for a lathe, milling machine, or hand screw machine at times when none of the women have been in the training room for the full two weeks. In such cases a woman will often be sent out to the shop after she has only been employed in the training room for a few days.

Woonsocket is a manufacturing town, and employment is found chiefly in either the mechanical or weaving indus-

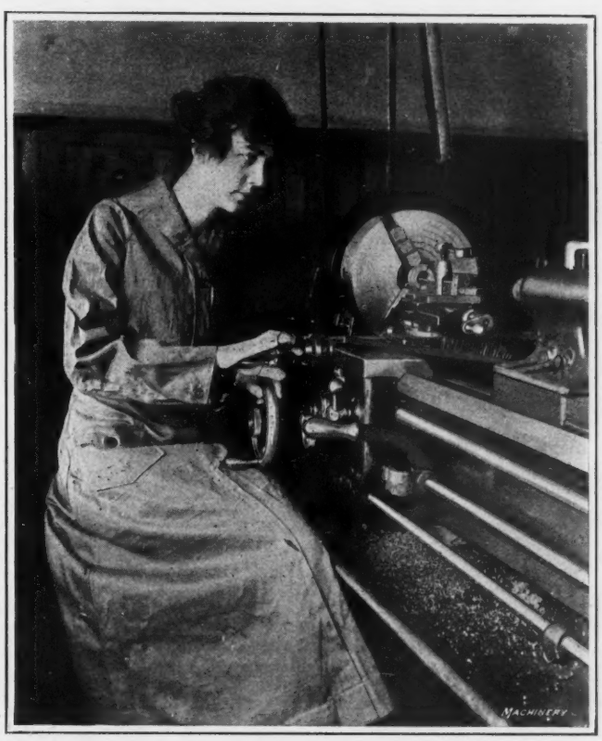


Fig. 1. Girl cutting Threads in Training Department of the Taft-Peirce Mfg. Co., showing Standard Uniform adopted for Women Employes

[1]Associate Editor of MACHINERY.

try. Women who come to the Taft-Peirce Mfg. Co. seeking work in the machine shops have usually left one of the weaving mills or a department store. This point is of interest in comparing the working conditions of a woman before and after changing her place of employment and in endeavoring to forecast the probability of such women remaining satisfied with conditions of employment which will surround them in the average machine shop. So far as a comparison of conditions in the weaving mill and machine shop is concerned, there is little to be said. The hours of employment are practically the same and girls probably earn about the same average wage in either industry. The machine shop has one advantage in that it offers more variety of employment, as a girl is engaged at different tasks from day to day instead of being constantly employed in performing exactly the same operation.

Employment in the machine shop certainly has many features to commend it as compared with working in a department store. In making such a comparison, it is necessary to consider conditions in any given town, and at present we are interested in the change made in a girl's life when she leaves employment in a Woonsocket department store and goes to work in a machine shop in that town. The department store is open from 8:30 in the morning until 6 at night, but this does not mean that the department store clerk is able to leave her counter promptly at the closing hour. It frequently happens that a customer enters a few minutes before 6 o'clock and will not have completed making a purchase until a few minutes after that hour. In any case, the clerk will have to put her counter in order ready for the opening of business the following day, so that it is generally 6:30 or later by the time she is able to leave the building.

As compared with this, the girl working in a machine shop is able to leave her work promptly at quitting time. In fact, in the shops of the Taft-Peirce Mfg. Co., she is allowed to stop work five minutes ahead of the men employed in the same department, in order to have an opportunity to be on her way home before the men are out of the building. Also, there are practically no classes of machine shop work on which a girl is employed where she cannot sit down for a considerable part of the day, even though her work is of such nature that it requires her to stand for a portion of the time. The girl in a department store does not have this privilege; she must stand all day, and she is continually faced with the problem of trying to satisfy the whims of exacting customers who are likely to be very hard to please. In many ways, the girl employed as a department store clerk is subjected to nervous strains and vexations of which the machine shop employe knows nothing.

Experience of the Taft-Peirce Mfg. Co. with the employment of women has shown conclusively that a girl will not long remain satisfied in the machine shop unless she is placed near enough to another girl so that she can have someone to talk to. For this reason, a practice is made of never sending one girl into a department where one or more other girls are not already employed, and all of the girls in a department are either placed in one section or else they are distributed in pairs in order that they may have an opportunity to talk with each other. Mention has already been made of the fact that girls are employed as operators of lathes, hand screw machines, and plain milling machines, but this by no means represents the entire range of work on which women are employed. Much of the inspection is done by women, and in many cases they have demonstrated their ability to handle this work in an extremely creditable way. They learn to read micrometers and use special gages as easily as men, and the greater nimbleness of the woman's fingers enables her to handle small parts more rapidly than a man.

Fig. 2. Corner of Training Department, where Girls are taught Use of Various Machines before going into Shop

Women are also employed on a great variety of light repetition work, such as filing, and it is perhaps noteworthy that experience has shown a woman employe to be willing to continue on the same class of work almost indefinitely, while a boy or young man soon becomes restless if he is kept long on the same operation. This is probably due to the fact that the woman merely regards her employment in the machine shop as an interlude between the time she leaves school and the time she will be married. On the other hand, a boy expects to increase his earning capacity by making a capable machinist of himself, and he is always anxious to obtain as much experience as possible in order to constantly add to his fund of knowledge. This desire for experience is doubtless the reason why a boy becomes dissatisfied if he is kept long on one particular class of work.

Employment of women in the Taft-Peirce plant has created certain problems which did not formerly exist. For instance,

it has been found necessary to provide a rest room and a room in which the women can eat their lunches; a room is also required in which medical treatment can be administered to women who become ill while at work. Employed at the plant there is a woman who has the title of "supervisor of female labor." It is her duty to go around the plant every day and talk to as many of the women as possible, the object being to learn of any cause for complaint which an employe may have, and either convince her of the injustice of her complaint or correct the cause, if the complaint is thought to be a just one. The woman chosen for this position has had a number of years' experience in settlement work, and as she has only two hundred women to look after, it is possible for her to talk personally with every one of them not less frequently than once in two days.

In some plants where women are employed as machine operators, some uniform style of dress has been adopted which is believed to combine the features of protection against dirt and danger of being caught in moving parts of machines. For instance, in many plants a cap, blouse, and trouserettes have been adopted as a standard working uniform for women employes, and these garments are usually sold to the women at cost. In the Taft-Peirce plant, the standard form of working uniform which is now worn by women is shown in Fig. 1. Some of the women formerly wore a long denim apron or loose-fitting coat reaching to the ankles, which served to protect them from the dirt and grease which is always found in every machine shop. Most of the women wear caps to protect their hair from dirt, and this is a measure strongly to be recommended in the case of all women employed in the machine shop.

For a number of years the Taft-Peirce Mfg. Co. has employed women in certain departments of its plant, but it has been the practice to segregate the women employes as far as possible. When the idea of giving employment to women in departments of the factory where men are employed was first brought up for discussion, the objection was raised that the presence of women would distract the men's attention from their work. Experience has shown, however, that there was really no need to worry over this point. The women settled down to work in a businesslike manner, and after the novelty of their presence had worn off, the men took very little notice of them.

The question is naturally asked: What is the future of the young woman who finds employment in a machine shop? The answer can only be guessed at, but it seems reasonable to assume that in the majority of cases she will continue as a machine operator until she either marries or becomes dissatisfied with her employment and branches out into some other line of work. During this period of employment, the woman working in a machine shop will earn more than it would be possible for her to do as a waitress, department store clerk, etc. A few of the women are making a conscientious effort to study the principles of mechanics and to acquire a knowledge of mathematics and mechanical drawing which will enable them to become more thorough masters of the trade. In rare instances of this kind, a woman may fit herself to fill some minor executive position, through careful application to her work while in the shop and by studying at home; but it seems safe to assume that the number who will become all-around mechanics will be comparatively small; and, in fact, it is not one of the objects of the training.

Fig. 3. Corner of Thread Lapping Department, where Girls are doing the Most Accurate and Sensitive Kind of Work

LARGE CONCRETE PLANERS

The tremendously large planers of unusual construction which have recently been built by the Amalgamated Machinery Co., of Chicago, Ill., represent an interesting and an entirely new departure in machine tool construction. Whereas formerly planers of this size would require at least two years in their construction, the new methods permit them to be completed in from two to three months. A battery of four of these planers are already in operation, the bed of these planers being 184 feet long and 17 feet wide. Each of these planers weighs some 2,500,000 pounds containing approximately 212,000 pounds of iron and steel parts, and 13,500 cubic feet of concrete reinforced with 34,000 pounds of steel bars. The principle of the construction was referred to in an article in the December 1917 number of MACHINERY entitled, "A Reinforced Concrete Boring Mill."

The bed of the planer is designed like a huge concrete girder which accounts for the large proportion of reenforcing steel bars. The platen of the planer moves on cast-iron ways on top of the concrete bed. The platen weighs 69 tons. This gives a fair idea of the enormous proportion of these machines, which are probably the largest ever undertaken in machine-tool building. R. M.

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NON-ESSENTIAL WORK

It is the patriotic duty of mechanical workers at present to select some kind of work which is essential to the prosecution of the war. Many machinists and toolmakers engaged in machine tool work, which is the most fundamental and essential of war industries, have been known to quit in order to obtain slightly higher wages elsewhere in the manufacture of articles that are non-essential so far as winning the war is concerned. In so doing, they fail as patriots.

Our Government has not closed down non-essential industries by compulsion because it expects the American people to curtail those industries, if it becomes necessary, of their own free will. It expects men whose services are required in work necessary for winning the war to refrain from turning deliberately to work in industries that are less important for that purpose or not essential to it at all. Freedom to choose one's occupation is one of the many liberties inherent in American institutions, but it implies the duty of choosing such work as will in some way benefit the American nation in these critical days. Before a mechanic, be he manager, superintendent, toolmaker, or machinist, changes from work essential to the conduct of the war to non-essential work, he should ask himself: "Am I injuring the cause of my country? Am I depriving it of my help in this crisis?"

* * *

MAKE INDUSTRIAL WORK SAFE

Boiler explosions in the United States have averaged a total of 281 annually for the past fifty years. They have killed, on the average, 256 persons a year; they have injured 380. The fatality rate in the United States, from 1910 to 1914, was 2.1 for each million inhabitants; in the United Kingdom it was 0.5; in Germany it was only 0.1. These startling statistics were given by Fred. S. Crum, of the Prudential Insurance Co., at the Industrial Safety Congress of New York state, held some time ago at Syracuse. The disparity between the figures for the United States and those for foreign countries is so striking as to point most definitely to the need for more care in providing safe boilers in the power plants of our shops and factories. That such measures for safety are feasible is proved by the experience of other countries.

Now that the lives of so many of our best young men are destined to be sacrificed in war, it behooves us to bend every effort toward decreasing the casualty list of peaceful endeavor. Industrial accidents have killed more men in this country during the last ten years than were killed in the British army throughout a whole year of fighting on all the British fronts. There must be greater safety in the operation of machinery; that cannot be emphasized too strongly nor repeated too often.

* * *

CAUSES OF EXCESSIVE LABOR TURNOVER

The reduction of labor turnover is one of the important problems in management at the present time. To solve this problem successfully, it is necessary to find out why employes leave their work or why it is necessary to discharge them. Statistics compiled in some of the larger plants in the country show that out of 100,000 employes who changed their occupation, about 75 per cent left of their own volition, 12 per cent were laid off because of lack of work, and about 13 per cent were actually discharged.

An inquiry into the reasons for the leaving of the 75 per cent who might have been retained is important in order that the causes of dissatisfaction may be removed, if possible. When men leave because they secure better jobs elsewhere, the wise employer will try to ascertain in what way he can successfully compete in the labor market. It is of importance to know whether the men leave on account of dissatisfaction with pay or for other reasons. Sometimes men leave because they think the work is too hard. A slight change in the working conditions might entirely alter this opinion; it may be that the work-rooms are too hot or too cold, or that simple lifting devices or trucks are lacking. Very small causes sometimes are at the root of serious labor difficulties. As a matter of fact, in many instances, where bigger pay obtained elsewhere is given as a reason for leaving, it is often the case that if the working conditions had been satisfactory, the man would not have been thinking of leaving. A study of the working conditions, therefore, is of prime importance.

* * *

DANGER TO AMERICAN TRADE NAMES IN FOREIGN COUNTRIES

American manufacturers have recently discovered an apparently organized effort on the part of business pirates in some of the Latin-American republics to deprive them of the use of their trade names when they enter those foreign markets. The trademark laws of these countries give the right to use a trade name to whatever person first registers it at the National Trademark Bureau. As a result of this, several American automobile firms, to take a few special instances, have found that they will be prevented from doing business in parts of South America because their trademark has been registered there by other parties, unless they reach some agreement with these unscrupulous gentry. It has been suggested—probably not without reason—that German business interests are resorting to these unscrupulous methods in order to drive the rightful owners of trademarks from the foreign business field. Syndicates have been formed in the Central Empires, it is said, for the purpose of registering American-owned trademarks in Latin America.

The thirteen nations that subscribed to the Berne Trademark Convention pledged themselves to recognize trademarks and patents filed in Berne exactly as if they had been registered in each of the said thirteen countries, the purpose being to afford protection to the real owners of patents and trademarks. But this purpose has been defeated, it seems, since commercial buccaneers have been trying to obtain the right to use some of the best-known American trade names merely by registering them in Switzerland at the International Trademarks and Patent Offices of the nations belonging to the Berne convention.

The only way that American manufacturers can protect themselves against these practices at the present time is by invariably registering their names or trademarks both at Berne, Switzerland, and in the various countries which are not parties to the Berne agreement.

The Essential Industry—to Win the War

"WE are out to win the war—not to build wonderful mechanisms." Here is a slogan not only for American engineers and manufacturers, but, properly interpreted and applied, for every man and woman in the country. It was an engineer who has been closely connected with the manufacture of ordnance materials who uttered the sentiment quoted above—he was commenting upon certain extreme requirements of the Ordnance Department—and he was *right*. It is not extreme accuracy and great precision we want. We want guns, shells, airplanes, motors, ships, uniforms—everything to make war with, and we want them as fast as we can get them, whether they are fine pieces of mechanism or just ordinary products, so long as they are capable of doing the work for which they are so badly wanted.

"I shall expect every man who is not a slacker to be at my side throughout this great enterprise."

Woodrow Wilson

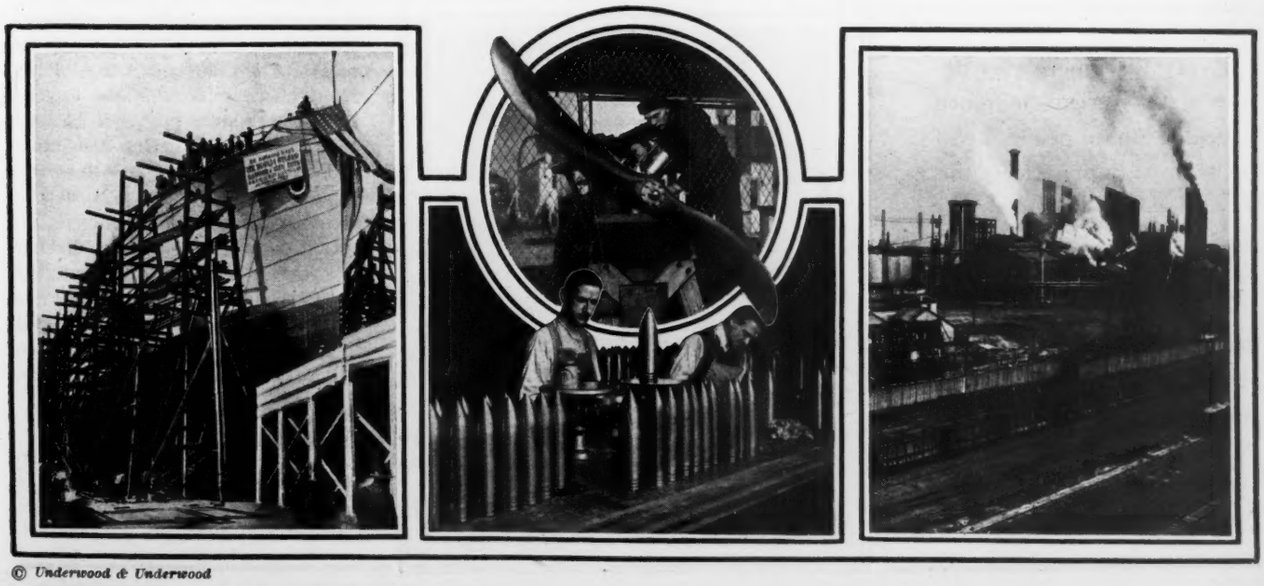
We are out to win the war—not to make excess business profits, nor excess labor profits either. We are out to win the war and the very last thing for anyone to be thinking of is personal advantage. We are out to win the war and every inhabitant of this free nation should get in line. One can almost hear the voices of the ragged and devoted old patriots of other days calling from Bunker Hill and Valley Forge, from the Wilderness, from Manassas, from Antietam, from Fredericksburg and Richmond—the men who won American independence, and the men who saved and kept the Republic. It is up to *us* now. Are we worthy of them?

The nation, like the heroes of the sea, must strip for action. And here we have the true test for differentiating between essential and non-essential industries. Every industry or occupation that directly or indirectly aids in the winning of the war is an essential industry. Conversely, those which are of no help in this respect are, for the time being, non-essential. But this important distinction should be made in every case with great care and with an open mind, for it is very easy to draw the line within too narrow limits. In addition to those industries which directly produce war materials, every industry and occupation which helps men and women to more efficiently discharge their duties in war work and related activities is essential. Whatever helps the worker is essential. Pleasure and recreation even are essential, and for the same reason. We are out to win the war—not to quibble over minor details. All our energies should be focussed on war work.

Industries that are clearly non-essential should be converted into agencies for producing war material. Nothing need be scrapped—trained organizations and useful equipment should all be utilized. Jewelry manufacturers, for example, are equipped to make many small parts used in instruments required by the Government, and if the need arises, the Government should call upon all those industries for assistance. Even the distilleries can be turned to useful purposes, and many of them have been so employed. Enormous quantities of pure alcohol are required in connection with the war industries, and the distilleries will supply this instead of turning out the beverages produced in the past. And as the nation gradually becomes adjusted to war-time conditions, practically all industries are mobilized. This is the one great purpose toward which all efforts must be directed.

The engineering journals have an important duty to perform in this connection, and it is the consensus of opinion that, on the whole, they have risen to this great occasion. It is their function not only to collect and disseminate the essential, mechanical, and industrial information needed in the production of war materials, but also it is their great privilege to interpret to their respective trades the correct spirit and attitude toward the Government and the nation's purpose. Being perfectly familiar with the special fields they serve, they can bring home to their readers more definitely and specifically than can the daily press or any other agency the actual methods by which each trade can be most useful. They can point the way toward increased efficiency through new machinery and new methods, and can distribute for the benefit of thousands of shops throughout the country the practical and invaluable experience of other shops engaged in the production of all the materials required for winning the war as quickly as possible.

For the time being, then, we have but one objective as a people and but one great national industry—to win the war. Every engineering endeavor, every industrial effort, must be directed toward this all-important end. For the time being, nothing else matters. We owe it to those who fight for us in France. We are out to win the war.



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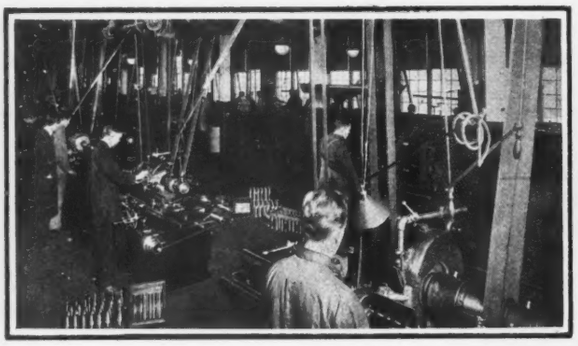
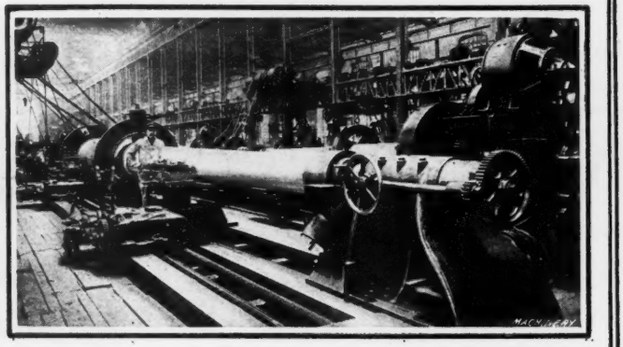




Loyalty of Labor—the Keynote of Victory

BY B. M. W. HANSON

Vice-president and General Manager, Colt's Patent Fire Arms Manufacturing Co., Hartford, Conn.

THERE is but one way—and one only—in which we could possibly lose the war, and that is through greed of money, disloyalty, and inefficiency of the great industrial army at home. If labor does its share of the work required for winning the war with only a fraction of the unselfishness and the willingness to do its duty that characterizes the splendid American army in France, there is not a shadow of a doubt as to our winning the war, and winning it in so decisive a manner that we will forever be safe against the Prussian menace.

Two Armies Necessary to Win the War—One Military and One Industrial

No matter how courageously and gallantly the army in France fights for American ideals, it must be supported by the great industrial army at home. We have in the United States, at the present time, all the plant and equipment needed for turning out a sufficient number of rifles, machine guns, shells, fuses, airplane motors, trucks, and ships for equipping and maintaining not only our present army in France, but an army several times as large. We have also all the plant and equipment necessary for turning out small caliber guns, although there may still be some additional facilities required for turning out all the large caliber guns that may be needed to bring the enemy to terms. We have all the raw materials required for producing the ordnance and munitions of war necessary for equipping the army, and we have the leaders and organizations able to direct and handle the work. We have all the labor that is required, both skilled and unskilled, *providing this labor is effectively applied to the machinery and the materials.* The apparent shortage of labor is due not so much to an actual shortage as to the constant changing of men from shop to shop, without consideration of the needs and requirements of the nation, and with no thought other than of their own selfish interests.

This is not the Time to Consider Personal Interests

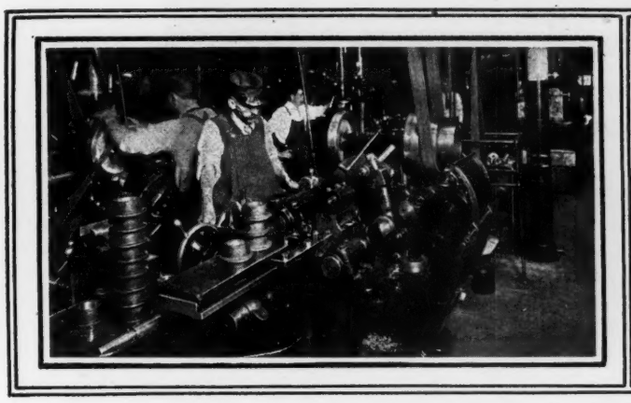
In time of war, the industrial army must do its duty as well as the military. At the present critical time, no man should consider it his right to think only of his own interests or to live his life in his own way. Being authoritatively directed by its leaders, the spirit and discipline of the military army makes it possible to accomplish the great things that have been achieved in driving the enemy back in France. The industrial army, in order to become efficient, must also be guided by experienced leaders, and its management must be left to trained men just as much as that of the military army. In time of peace men may be entitled to follow their own inclinations, but in time of war the industrial army should be required to do its duty as strictly as the men in uniform. To incite men engaged in the manufacture of war materials to strike is to directly and effectively help the enemy, and men who devote their time to strike agitation at this time are aligned with the forces of disloyalty. We cannot afford to deal leniently with such conditions at this time. We are at war, and we must recognize it at home as well as in the field.

What would happen to an army in which the soldiers were permitted to combine with a view to refuse to fight until differences between the soldiers and their officers had been settled by the Government? Russia demonstrated what happens to an army and to a country represented by such an army. The effect is the same in the industrial army. If, in a critical time like this, the production of war materials is to be held up by agitation creating discontent and strikes, it may spell defeat and disaster. The results may not be so immediately disastrous or so apparent as would those of similar disaffection of the army at the front, but the actual effect is equally disastrous in its relation to the progress of the war and on the ultimate and decisive victory.

German Propaganda Cause of Labor Disturbances

There is no doubt that German propaganda is responsible for a great deal of the agitation among

Every workman who believes that "right is more precious than peace," will be as loyal to his job at the anvil, bench, or machine, as the men who fight and die on the battlefield. From the calloused hands of our great industrial army come the steel sinews of war, but the hands that are idle, work for Prussianism and tyranny.



labor at the present time, and every American workman who means to be loyal to his country should remember that he is listening to German propaganda and furthering the war aims of the enemy whenever he listens to any man who aims to stir up industrial strife and discontent. The American workman should try to realize that the outcome of the war depends upon the rapidity with which he turns out war materials, and that his loyalty to his country is measured directly by the amount of useful work of which he is capable. He is a soldier as important as the man in khaki at the front, and, by faithfully doing his duty, will save the lives of his countrymen who are freely sacrificing their all at the front. During the period of the war, differences between employer and labor must cease to occupy his mind, and the management of industrial plants must be left in complete control, in order that production may be increased in a greater ratio. The Government should enforce the laws relating to German propaganda in the strictest possible manner, and back up the manufacturers of war materials in any case where a higher degree of efficiency may thereby be obtained. If the dupes and disloyalists who aim at decreasing the efficiency of our production of war materials, through making labor dissatisfied and inefficient, were quickly and severely dealt with, the propaganda would cease, and we would be able to keep our great army at the front well supplied with all the materials needed for a speedy victory.

The Government Must Handle the Labor Problem with Fairness and Courage

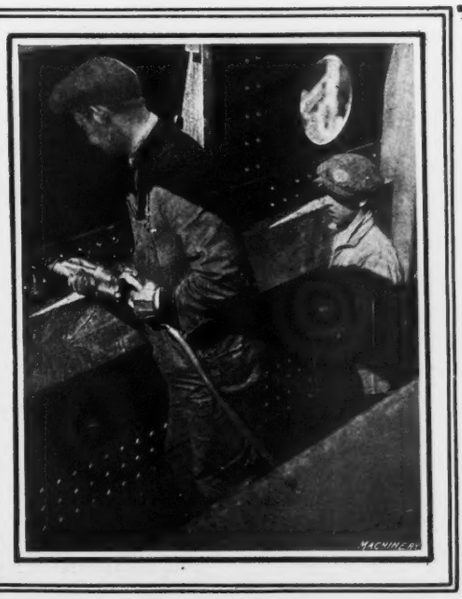
The Government has a difficult and delicate problem to deal with in the labor situation during the war, but its officials must exercise enough moral strength and courage to demand of the industrial army at home that it shall do its duty with some measure of the loyalty and unselfishness required of the army in France. Of course, there is no comparison between the sacrifices demanded of the two armies. The army in France suffers untold privations, and the soldier is ready to give his life at any moment. The industrial worker at home sacrifices little or nothing; he is well paid, he is well fed, and he is well housed; he has pleasures and enjoyments that the men at the front must forego, and the only thing that is asked of him is that he work six days a week producing the war materials that are needed. The Government, therefore, has an absolute right to demand of the workers of the country that they do not hamper the army at the front, and this right the Government should exercise as earnestly as it would exercise its right to put down disaffection and treachery in the military army. The faithful and loyal work of every man is required for victory.

Policy of Standardizing Wages of Doubtful Value

The policy inaugurated by the Government for fixing minimum and maximum wages is of doubtful value, as it takes away the individual incentive and makes it impossible for the manufacturer to give suitable rewards for exceptional service. If every worker fully realized his importance to his country, so that he would do his very best when assured not only of a fair but of an exceptionally high wage, the policy of standardizing wages might do no harm, but, unfortunately, many workers, and especially the agitators, fail to realize the essential part the worker in the industrial army plays in war time; hence, there is still needed a personal incentive to make each man do the best work of which he is capable, and this incentive is lacking if every man is paid a uniform wage. Whatever new policies are formulated, this thought should be kept in mind throughout: That the loyalty and efficiency of labor are the two important considerations at the present time, and that the production of war materials is more important than the individual interests of any man or any group of men.

Our Worst Menace Just now is not the German Military Machine

As I see the situation in the United States, therefore, the worst menace to our success is not the German military machine, as I absolutely believe that the Allies, with the great assistance of our American soldiers, will put an end to the tyranny of the Kaiser; but it is the agitator, whom I believe to be in some way connected with German interests, that constitutes our greatest danger; and unless we deal with him fearlessly and quickly, making, if necessary, special laws for this purpose, much of the blood now spilt in Europe will be shed in vain. Why should American workers permit unscrupulous men, aiming to serve nothing but their own selfish purposes, to ruthlessly sacrifice the interests of the Nation and of mankind?



Let the work that you do every day be dedicated to the manhood that is in you, that you shall have no remorse when broken men come back from the battle-front—so that empty sleeves and sightless eyes shall not reproach you by day and haunt you by night because you at home failed to support our men while they fought in France.

Photographs © by Underwood & Underwood

Organizing a Liberty Loan Campaign

Methods Employed by the Brown & Sharpe Manufacturing Co., and the Cleveland Automatic Machine Co., to Arouse Interest of Employes in the Liberty Loans

THE fourth liberty loan campaign will begin September 28th, and close October 19th. The great preliminary campaign is now on and the more planning we do beforehand, the easier it will be to secure a big over-subscription. The manufacturers of the country have an unusual opportunity for becoming bond salesmen for Uncle Sam. By organizing a local campaign in your shop the interest of employes can be aroused, but sticking a few posters about the plant is not enough. A direct appeal to every man and woman employed in the various shops and factories throughout the country is essential.

CAMPAIGN AT THE WORKS OF THE BROWN & SHARPE MANUFACTURING CO.

By Luther D. Burlingame, Industrial Superintendent

When at the beginning of the third liberty loan campaign the question was raised among some of the Brown & Sharpe officials and managers as to how great a response could be expected from the employes, there were those who predicted smaller returns than for the second issue, because of living conditions and the frequency of preceding appeals. The problem thus presented was to so inspire the employes to help and to put the matter so strongly upon their consciences that they would be willing to subscribe to such an extent that these predictions would not come true. The plans adopted were so successful that the subscriptions to the third liberty loan exceeded those of the second by about 25 per cent. The general plan of campaign adopted is to be described so that a method which has proved successful for the third liberty loan in at least one plant, may be applied to the fourth loan by thousands of managers throughout the country.

General Plan of Campaign

The means of arousing interest in the purchase of Liberty Bonds among the employes of the Brown & Sharpe Mfg. Co. were as follows:

1. Notices in the pay envelopes.
2. Personal appeal and solicitations by foremen and others assigned to the task.
3. An appeal to sentiment and patriotism by dedicating an old shop bell to Liberty.
4. Public meetings, with patriotic addresses and music.
5. Competition between departments for prize banners.
6. The use of bulletin boards.

The campaign was opened by inserting notices (see Fig. 1) in the pay envelopes. These notices which were of a size to fold conveniently with bills, explained the terms on which the company would cooperate. The time of payment was spread over a period sufficiently short to have the payments completed by the time it was expected the next loan would be issued, thus following a policy which has been adhered to by the company from the beginning of the first liberty loan campaign, and avoiding the handicap which comes when solicitations for new subscriptions must be made before the employes have completed payments and received their bonds of the earlier issue.

Employes who subscribe for Liberty Bonds may be divided into four classes: First, those who come forward and voluntarily subscribe; second, those who wait to be asked but readily subscribe; third, those who have to be argued with and convinced that it is their duty before subscribing; fourth, those who refuse, and whose subscriptions are only secured after further effort.

Following the sending out of the notice in the pay envelopes, an amount was subscribed almost equal to the total received for the first liberty loan, by the employes coming forward and placing their subscriptions before solicitation commenced.

In order to have a definite understanding with the employes regarding their subscriptions, blanks were used. The blank for fifty-dollar bonds is shown in Fig. 2. These blanks, together with general literature and instructions, were placed in the hands of the foremen, who personally took the matter up with the employes in their departments and materially aided in securing subscriptions. Generally speaking, it is believed to be far better to have the foreman, or someone personally acquainted with the men, solicit for subscriptions.

Dedicating the Old Shop Bell

A marker was devised to graphically show the point reached by the subscriptions from day to day. This was made in the form of a "Striker"—so familiar an accompaniment of every circus—and was exhibited on a structure over 30 feet in height in front of the main office building (see Fig. 3). It was appropriately located in close proximity to the company's service flag with its many hundred stars. A novel feature of this marking device was the mounting of an old shop bell in such a position that when the marker reached the predetermined goal the bell would be rung; and this made

a special incentive to bring the subscriptions up at as early a date as possible. The legend at the bottom of the "Striker" read:

"Dedicate to Liberty the old shop bell when we go 'Over the Top' by passing the goal of $200,000. It will then be rung and thereafter each noon at 12:05 when registering the amount subscribed."

This bell had been used in the old wooden shop on South Main Street occupied by the company in the early days of the business, and has since been preserved in the Historical Museum connected with the works. It was cast in the year 1863 by F. Fuller, the initials "J. R. B." which are cast on the bell being those of Joseph R. Brown, the founder of the business. On the scale of the marker were indicated the points which had been reached in the first and second liberty loan campaigns, and it added to the enthusiasm when these points were passed, but especially when the first goal of $200,000 was reached, and the bell was rung for the first time after its long silence of nearly fifty years. Each noon thereafter the bell was rung when setting the marker, the rapid rise of which often brought applause from the waiting crowd.

Noontime meetings were held every few days throughout the campaign, addressed by prominent and inspiring speakers, and accompanied by music, this latter being furnished for the most part by shop talent.

above referred to determining the standing, so as to equalize as nearly as possible the conditions of competition.

During the second liberty loan campaign, "outside" subscriptions were taken into account in making the awards. It was found, however, that certain employes, in order to stand well with their foremen and in their department, would subscribe outside, paying the first dollar or two on their subscriptions, and then drop their payments. For this reason, in figuring the standing of departments for the third liberty loan, subscriptions actually taken in the shop only were counted, thus eliminating any temptation to make "fake" subscriptions. At the close of the campaign, however, a census was taken to show the total number of subscriptions by employes, outside as well as inside the factory, and the percentage taken inside was found to be very much larger in proportion to those taken outside than for the second campaign.

The pressure brought to bear by fellow-workmen on those who failed to subscribe was often such as to be felt most strongly by the "slackers." In one department where all but two had subscribed one of the workmen brought in an effective cartoon which he had made, illustrating the situation and this is typical of the sentiment by which many a workman who might otherwise have "side-stepped" his duty, was led to subscribe through the influence of fellow-workmen.

As the need of redoubled effort throughout the country in order to reach the required allotments became evident, efforts

THIRD LIBERTY LOAN

Interest @ 4¼% payable September 15th and March 15th

Bonds due September 15, 1928 Not convertible into other issues

Employes may subscribe for these bonds through us in the same manner as the two previous issues. As it is expected that the fourth issue will not be brought out until fall, payments for this issue, if desired, will be spread over twenty-two weeks, instead of seventeen weeks as heretofore.

$3.00 per week will be deducted for each $50.00 bond for six weeks commencing with the pay for the week ending April 27th, and $2.00 per week for the following sixteen weeks.

The Bonds will remain the property of the company until the last installment is paid. Employes may receive their bonds at any time by making payment of the balance due. Subscriptions will be received until April 20th. The clerks in each department will take the names of those who desire to subscribe.

EVERY BOND YOU PURCHASE HELPS TO WIN THE WAR.

April 8, 1918. BROWN & SHARPE MFG. CO.

Machinery

Fig. 1. Notice placed in Each Employe's Pay Envelope at Opening of Liberty Loan Campaign

Competition between Departments

One of the best incentives to giving, for war charities—especially to free and cheerful giving—has been found to be in developing a spirit of competition, the rivalry making, in a way, a game of the campaign. This applies with equal force to obtaining subscriptions to liberty loans. To secure the benefits of such competition, a contest was organized, the company offering banners, for the large and small departments, as they had done with good results in the second liberty loan campaign. This had the desired effect of materially increasing the exertions by both foremen and workmen in arousing an added interest to have their departments excel. A committee was appointed to act as judges of the awards and they posted over their signatures the following notice:

The third liberty loan will have the hearty support of every loyal citizen who appreciates the present situation,—for himself, for his country and for the world.

This company gives its employes substantial help in furnishing these bonds upon the terms of payment already offered.

As a further aid to the campaign, the company also offers an honor flag or banner, suitably inscribed, to the department giving the most generous support to the loan.

In making the award account will be taken of the number of subscribers in proportion to the whole number employed in a department, and of the amount subscribed in proportion to the total wages paid in a department.

The competition will be limited to the company's employes and to subscriptions made through the company.

Notices like that illustrated in Fig. 4, were posted every few days showing the general standing of the departments in per centage of employes subscribing. When it came to the final showing the notice, Fig. 6, was used, the handicap plan

at the shop were increased, a higher goal, $300,000, was set and a direct appeal by the treasurer of the company, was made through the pay envelopes. (See sample, Fig 5.) This was supplemented by an appeal addressed directly to the executives and foremen, asking for renewed efforts on their part to secure subscriptions, and for suggestions as to how to increase the effectiveness of the campaign.

The amount subscribed for the first liberty loan directly through the company had been in "round figures" $100,000, and for the second loan $200,000; it thus seemed especially appropriate that the goal for the third loan should be $300,000, and an earnest effort was made to bring the subscriptions to that amount. One means used to accomplish this end was to have a strong and forceful editorial, urging the purchase of Liberty Bonds, which had been published in a local paper, reprinted and distributed to every employe. Steps were also taken to secure the publication of news items and pictures in the daily papers, telling of and showing the progress of the campaign at the works and thus keeping not only the employes but also their families informed and interested in what was being accomplished. In addition, a large banner, 15 by 25 feet, shown in Fig. 7, was provided; these various efforts to attain the desired goal added materially to the amounts otherwise subscribed.

Constant use was made of the bulletin boards to keep the workmen informed as to the progress of the campaign, one large poster being combined with a diagram of the "Striker" already described and this was marked in red to show the progress from day to day on the fifty bulletin boards of the shop. The legend on this notice was changed from time to

Third Liberty Loan Subscription

.....1918.

To Brown & Sharpe Mfg. Co.

I hereby subscribe to a $50 United States Liberty Loan 4¼% bond at its face value, and will pay for this bond in successive weekly installments. To cover these payments I hereby authorize you to withhold $3 per week from my pay for six weeks commencing with the pay for the week ending April 27th, and $2 per week for the following weeks until the bond is paid for in full.

It is agreed that I shall receive this bond with all coupons attached only when paid in full. Upon failure to make payments as agreed, you are authorized to sell the bonds for my account and pay back to me the balance due.

.....

Witness.....

Machinery

Fig. 2. Form of Agreement covering Terms governing Purchase of Liberty Bond by Employe

time by covering part of the original lettering with inserts, some of which read:

"Each subscriber gets a service flag. Are you going to have one to put in the window at your home? Record to Wednesday night, $167,700."

"Record to Thursday night, $182,500. Now for a swing that will ring the bell on Saturday noon. Will you help to put the marker 'over the top'?"

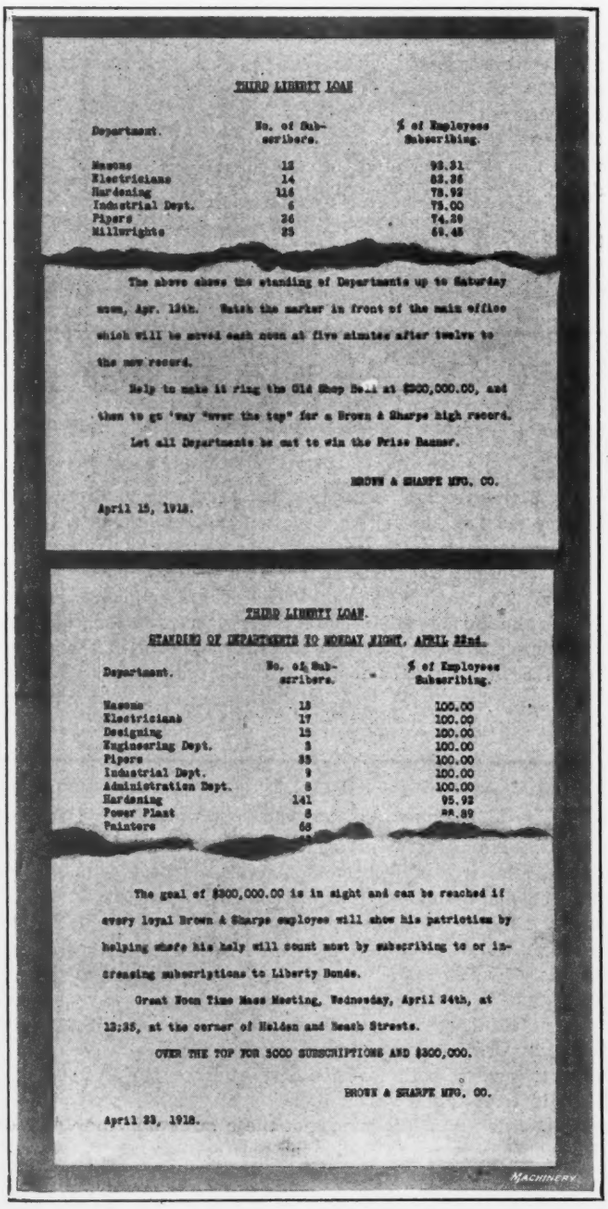
"We have reached the first goal, $200,000, and the old shop bell was rung Friday noon. Now for a swing that will drive the marker to $300,000."

At the close of the campaign a public meeting was held for the presentation of the banners to the winning departments, and a special letter of appreciation was presented at that time to each of the seven departments securing 100 per cent subscriptions. The amount subscribed for by employes went up to the grand total of $322,150, subscribed by 5,510 employes, being more than 76 per cent of the total force, including in determining the percentages, those out on the sick list, new employes, etc. These awards were made personally by Henry D. Sharpe, at the closing noontime meeting, Fig. 7.

The departments now holding the banners have them protected in glass cases. These banners are the envy of other departments, their constant exhibition proving a special incentive, as a new campaign comes on, for each department to strive to be the proud possessor of such an award.

The old shop bell, dedicated to Liberty, has acquired new interest as it hangs again in the Historical Museum.

Fig. 3. Liberty Bell marking Goal or Loan Quota on "Striker" which was used to stimulate Interest



THIRD LIBERTY LOAN

Department.	No. of Subscribers.	% of Employees Subscribing.
Masons	15	93.31
Electricians	14	83.36
Hardening	116	78.92
Industrial Dept.	6	75.00
Pipers	36	74.39
Millwrights	25	69.45

The above shows the standing of Departments up to Saturday noon, Apr. 13th. Watch the marker in front of the main office which will be moved each noon at five minutes after twelve to the new record.

Help to make it ring the Old Shop Bell at $300,000.00, and then to go 'way "over the top" for a Brown & Sharpe high record.

Let all Departments be out to win the Prize Banner.

BROWN & SHARPE MFG. CO.

April 15, 1918.

THIRD LIBERTY LOAN.

STANDING OF DEPARTMENTS TO MONDAY NIGHT, APRIL 22nd.

Department.	No. of Subscribers.	% of Employees Subscribing.
Masons	13	100.00
Electricians	17	100.00
Designing	15	100.00
Engineering Dept.	3	100.00
Pipers	35	100.00
Industrial Dept.	9	100.00
Administration Dept.	8	100.00
Hardening	141	95.92
Power Plant	8	88.89
Painters	66	

The goal of $300,000.00 is in sight and can be reached if every loyal Brown & Sharpe employee will show his patriotism by helping where his help will count most by subscribing to or increasing subscriptions to Liberty Bonds.

Great Noon Time Mass Meeting, Wednesday, April 24th, at 12:35, at the corner of Holden and Heath Streets.

OVER THE TOP FOR 5000 SUBSCRIPTIONS AND $300,000.

BROWN & SHARPE MFG. CO.

April 23, 1918.

MACHINERY

Fig. 4. One of the Notices which was posted frequently to show Percentage of Loan Subscribers in Different Departments

SELLING LIBERTY BONDS AT WORKS OF CLEVELAND AUTOMATIC MACHINE CO.

By J. P. Brophy, Vice-president and General Manager

In our first Liberty Bond campaign, before we attempted selling any bonds in our factory, we placed in the different departments thirty 16- by 20-inch posters. (See Fig. 9.) Also, we had a speaker address all the employes on the subject. When the campaign started the head of each department throughout the plant was delegated to investigate in his particular department and find out who wanted to buy bonds and how many bonds they were willing to purchase.

The heads of the departments were notified that they must use sensible persuasion in keeping the amount that the men purchased as high as possible and at the same time encouraging them to buy when they made complaints about not having the necessary funds, etc.

We did not meet with very great success the first few days; the men of American birth purchased freely but the foreigners were very slow at purchasing on account of the fact that quite a large percentage of our employes are from different countries—many subject to the Austrian Government—and they were pro-German. When this was found to be the case, the foremen were sent around again to all of these men and were instructed to bring as much pressure to bear as possible to make them purchase. We found that it was not

Third Liberty Loan

Can we enlist the cooperation of 5000 employes?

TO OUR EMPLOYES:

At the present time the Works give employment to over 7000 people. The campaign for the Third Liberty Loan has already secured participation from over 3700 employes subscribing for $220,000. In our opinion there should be 5000 subscribers furnishing not less than $300,000. The situation seems to show that the men receiving a lower wage are participating better than those receiving a higher wage. This may or may not be true. What we wish for is the participation of everyone who has a spark of patriotism in him. The fact remains that up to the present time only 52% of the force are cooperating.

Will you be one of 5000 to make the amount at least $300,000?

If you have subscribed already, will you help to induce your fellow employe to make his subscription?

If you have not already subscribed, will you not reconsider and do your "bit" in your country's hour of need?

We are all working for Uncle Sam and the boys "Over There,"—the Company and its stockholders as well as the employes.

The Company will advance monies without interest against payments extending over twenty-two weeks, when the bonds will belong to the subscribers.

Liberty Bonds are a prime promoter of THRIFT—an inciter to savings, which are of vital importance to all now; for the present busy period, incidental to the prosecution of the war, will doubtless be followed by a period of business stagnation, which generally means short time and unemployment.

Any man who buys a bond now should have no reason to regret it. On the contrary, he will have a greater pride in his country because he is performing a service in its defense.

Over the Top for 5000 subscriptions and $300,000!

BROWN & SHARPE MFG. CO.

April 20, 1918. HENRY D. SHARPE, Treas.

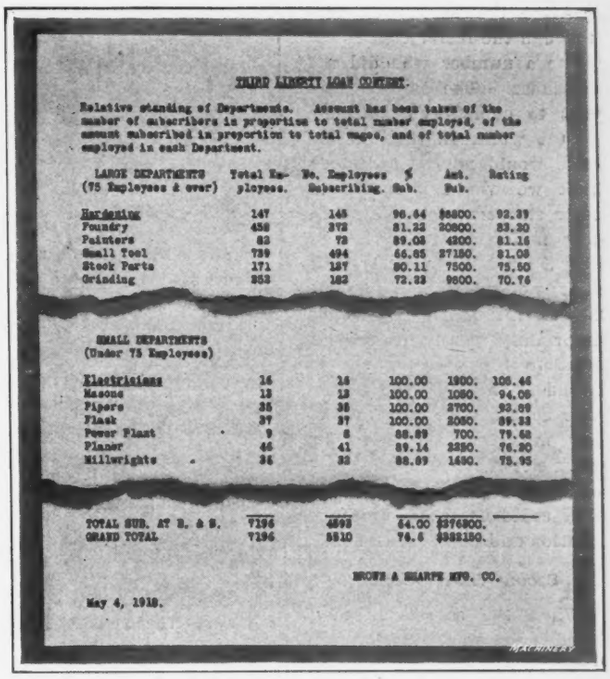
Machinery

Fig. 5. Form used in making Direct Appeal through Pay Envelope for Over-subscription

difficult to get the Bohemians to purchase, but the Hungarians, Poles, and some Russian Socialists were slow to respond.

After one week of this procedure, the writer then examined the list of bond buyers to see how many had actually bought and the value of each purchase. If in some instances a man bought a $50 bond where we were rather inclined to believe he should have bought a $100 bond we investigated all such cases immediately to discover the reason for not making a larger purchase.

The campaign was then started over again by going at it in a vigorous fashion and not taking "no" for an answer, as every man in the institution must purchase a Liberty Bond. The men were given to understand that there was no alternative but to purchase a bond; that we did not care to have anyone in our employ who ignored this great obligation to our country; that there was no possible excuse for not buying a bond, regardless of what the workman's condition might be at home, because of the long time payments or the paying so much every month until the bond was paid for, which is practically a savings account and a sensible thing for the man to do regardless of the great help to his country. In most instances this had good results and a vast number of men purchased who in the first place claimed they could not afford it.



THIRD LIBERTY LOAN CONTEST.

Relative standing of Departments. Account has been taken of the number of subscribers in proportion to total number employed, of the amount subscribed in proportion to total wages, and of total number employed in each Department.

LARGE DEPARTMENTS (75 Employees & over)	Total Employees.	No. Employees Subscribing.	% Sub.	Amt. Sub.	Rating
Hardening	147	145	98.64	$8800.	92.39
Foundry	458	372	81.23	20800.	83.20
Painters	83	72	89.08	4300.	81.16
Small Tool	739	494	66.85	27150.	81.08
Stock Parts	171	127	80.11	7500.	75.50
Grinding	253	183	72.33	9600.	70.76
SMALL DEPARTMENTS (Under 75 Employees)					
Electricians	14	14	100.00	1900.	108.44
Masons	13	13	100.00	1050.	94.05
Pipers	35	35	100.00	2700.	93.89
Flask	37	37	100.00	2050.	89.33
Power Plant	9	6	66.89	700.	79.62
Planer	46	41	89.14	2250.	76.90
Millwrights	36	32	88.89	1450.	73.95
TOTAL SUB. AT B. & S.	7196	4693	64.00	$376800.	
GRAND TOTAL	7196	5810	76.6	$388150.	

BROWN & SHARPE MFG. CO.

May 4, 1918.

MACHINERY

Fig. 6. Final Results of Liberty Loan Campaign

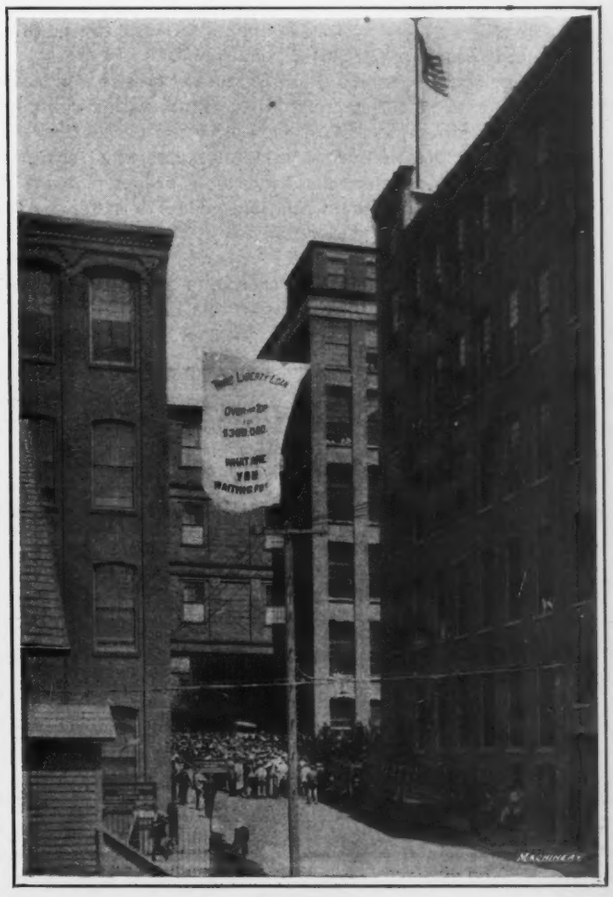


Fig. 7. Campaign Banner and Part of Crowd of 1200 at Noontime Meeting

After the second attempt through the factory, we found quite a number who did not purchase. The next move was to explain emphatically to the workman that his excuse would not be accepted; that we would not care to have slackers of this kind in our employ; that they had to buy a bond immediately, and that we would not tolerate having men who were doing their duty work with others next to them failing to respond at these critical times. The consequence was that a few men left and went to work elsewhere, but the greater number discovered that they could not evade this obligation and purchased a bond.

Second Liberty Loan

When the second Liberty Bond sale was started, we had another speaker address all of the employes, advising them to purchase. We then hung large posters in every room in the factory. (See Fig. 8.) Each foreman was again instructed to act as a solicitor in his department. As experienced in the first campaign, the sales of the second bonds were not as numerous as we had hoped for at the beginning, the foreigners holding back as before, and we decided that more strenuous means must be taken to force them to purchase. A Hungarian speaker was engaged to address the foreigners in the Hungarian language and another notice was posted in every department. (See Fig. 10.) Results of this last notice began to be noticeable during the next two or three days, and bonds were purchased very freely.

We found upon exerting the greatest possible pressure upon foreigners that there was outside intimidation going on. Many of these men gave as an excuse for not purchasing that their families lived in Europe, some of them owned property, and that if they purchased a bond their property would be taken from them and their relations made to suffer. Also, that if they ever went back again to their own country they would be liable to be shot. Some few cases were found where the men absolutely refused to purchase on account of their pro-German attitude, and in instances of this kind the men were given the choice of purchasing a bond or being discharged.

"Help Win the War"

4% Non-taxable 2nd Liberty Loan Bonds

It is MORE necessary for you to buy one or more of these bonds than it was to buy during the First Liberty Loan Campaign.

Remember, this is saving your money and at the same time standing back of the soldiers who are going to fight.

Any employe of this company can buy one or more of these bonds at the rate of

$1.00 per week on a $50.00 bond
$2.00 per week on a $100.00 bond
Same ratio for larger amounts.

The money to be taken from pay and a receipt placed in pay envelope.

You will draw 4% interest while paying.

Your money will be refunded if you leave our employ for any reason before bond is entirely paid for.

Orders will be taken by a man in each department.

BUY A BOND

THE CLEVELAND AUTOMATIC MACHINE CO.
Machinery

Fig. 8. Posters for Second Liberty Loan, placed in Every Room at Plant of Cleveland Automatic Machine Co.

We paid no attention to the above excuses, realizing the insincerity of their arguments and that they were coached by pro-Germans as to just what to say. Some purchased when they found they were forced to and others were discharged.

Third Liberty Loan Campaign

The third liberty loan campaign was carried along in practically the same way as the second, with nearly 100 per cent results in our factory. In a few exceptional cases we discovered that some men who were not receiving very high wages, had large families, sickness, etc., and were really not in a position to purchase even a $10 bond, let alone a $50 bond. This was only in a few instances and, of course, we did not have the slightest idea of working an injustice on anyone, and as such cases as this were well known by the men who did purchase bonds, this did not cause any bad feeling within the plant.

It will be understood by this that practically every man in our employ was forced into buying a bond. If we had not used this force, about half of our men would have made a purchase. Some were under the impression that when they bought bonds they were actually donating to the Government but as the result of our campaign they finally realized they were banking the money. With a number of men some argument was required to show them they were benefiting themselves and at the same time were supporting the government in this war.

On the easy-payment plan, a number of men stayed in our employ until the bond was nearly paid for and then demanded their money. In the last campaign we informed the men that regardless of how much they payed on the bonds when they left our employ they would have to keep on sending in their monthly payments until the full amount was received by us and then we would deliver the bond. This arrangement did not affect in the least the amount of the third issue that was sold, and on the next loan no money will be refunded.

Show Your Patriotism!

We now have Liberty Bonds from $50.00 to $500.00 for sale on the following terms:

On a $50.00 bond we will deduct from your salary $1.00 per week until paid for.

Bonds up to $500.00 on the same basis; that is, $10.00 per week for a $500.00 bond.

You will draw interest on these bonds while you are paying for them.

If you leave our employ or are discharged before the bond is paid for, we will return your money.

This is an opportunity to serve your country and procure a bond on extremely easy payments.

We will send men around to take your name tomorrow.

THE CLEVELAND AUTOMATIC MACHINE CO.
Machinery

Fig. 9. Poster Used by Cleveland Automatic Machine Co. at Beginning of Campaign

NOTICE

We expect every man in our employ to buy a bond. If not, we want to know the reason why.

It makes no difference if you are not a citizen when you are earning good money in this country.

This is no time for flimsy excuses. Be prepared to answer questions we will ask if you are not a bond holder.

This is especially intended for foreigners who are reaping the benefits of living in the United States but who have not become citizens.

Remember that this is a time of war, and it is the duty of every man, whether he is a citizen or not, to do his duty to protect the country in which he lives.

THE CLEVELAND AUTOMATIC MACHINE CO.
Machinery

Fig. 10. Poster intended especially for Employes not interested in buying Liberty Bonds

Making the Mark III Detonating Fuse

By Edward K. Hammond[1]

First Installment of an Article Dealing with an Important Phrase in the Manufacture of Munitions of War

THE Mark III detonating fuse which has been adopted by the United States Government for use in various sizes of high-explosive shells was originally developed by the French for use in their 75-millimeter shells. Fuses of this type are being manufactured for the United States Government by the International Steel & Ordnance Co., of Lowell, Mass., and the following description of methods used by this firm, which have resulted in the successful production of fuses at the rate of approximately 28,000 a day, will prove of interest for two reasons: First, a number of the features of this company's procedure in the organization of departments, methods of routing work through the plant and checking production are unusual. Second, the description of methods used for machining the different fuse parts, and of inspecting all parts after each successive operation has been performed on them, will be of interest and value to manufacturers who are taking up similar lines of work. The officials of the International Steel & Ordnance Co. are as follows: T. A. Gillespie is chairman of the board of directors and T. H. Gillespie is president. The plant in Lowell is operated under the direction of George R. Townsend, vice-president and general manager; F. W. Willard is general superintendent and R. P. Kidder is chief engineer.

Description of Mark III Detonating Fuse

Before starting a detailed explanation of the methods employed by the International Steel & Ordnance Co. in manufacturing parts of the Mark III fuse, and inspecting and assembling these parts ready for shipment to the fuse loading plant, it will be of interest to the reader to learn of the features of this type of fuse and the way in which it operates. The best idea will be secured by referring to Figs. 1, 2, and 3, which show, respectively, a cross-sectional view of the assembled fuse and views of those parts of the fuse which are made at this company's plant. Referring to Fig. 1, it will be seen that the main parts of the fuse consist of a body *A* and base *B* which are made of brass, and a cap *C* and firing pin *D* which are made of cold-rolled steel and zinc-plated before being assembled into the completed fuse. For the sake of simplifying the description, firing pin *D* has been referred to as a single unit, although it will be seen that a safety pin *E*, washer *F*, and head *G* are assembled on the pin. It is these main parts of the fuse (and also the parts of safety spiral *H* which will be described in the following paragraph) that are manufactured at the plant in Lowell; the remaining parts are power press products, and these are assembled into position after the fuses have been sent to the loading plant.

How Fuse Operates

It is a matter of general knowledge that the bore of a field gun is rifled, that is to say, helical grooves are machined in the bore to provide for imparting a rotary motion to a shell fired from the gun. This rotary motion performs other important functions in determining the accurate flight of a shell, but it is upon the fact that while in flight a shell also has a rapid motion of rotation that the operation of the Mark III fuse is based. To avoid danger of premature explosion, high-explosive shells are sent to the battlefield with plugs screwed into the threaded hole in the nose, and the fuses are sent to the field in separate boxes. In preparing a shell for use, the plug is removed and a fuse substituted in its place. Obviously, it is now necessary to provide some safeguard which will prevent accidental explosion of the shell through unintentionally striking head *G* of the firing pin in the fuse. This result is accomplished by having a spiral brass ribbon *H*, which has its inner end secured to a projection on one of the half rings surrounding the firing pin, and weight *I* attached to its outer end, wrapped around the firing pin to fill the space between washer *F* and head *G*. It will be apparent that with this spiral ribbon in place it is impossible for firing pin *G* to be forced down into contact with fulminate cap *J*, which would result in exploding the fuse and shell in which it is mounted.

When the shell is fired from the gun, it is necessary for

[1]Associate Editor of MACHINERY.

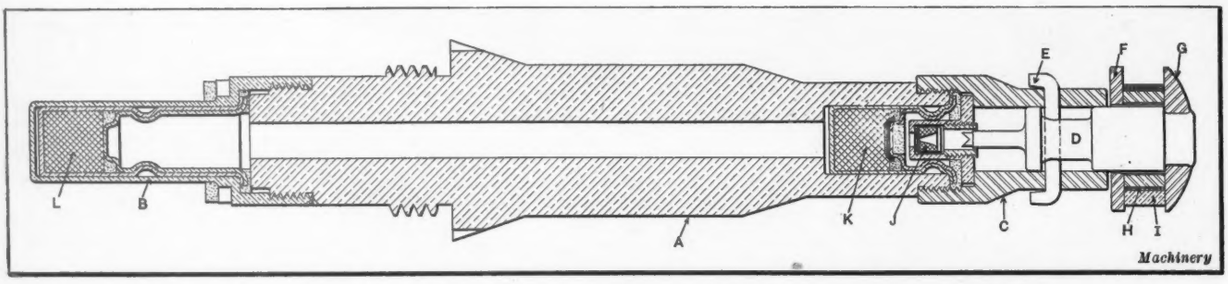


Fig. 1. Cross-sectional View of Mark III Detonating Fuse, illustrating Way in which this Type of Fuse operates

safety spiral *H*, weight *I*, and the two half rings to be removed, and this result is automatically accomplished through the action of centrifugal force. The rotary motion imparted to the shell by the rifling in the gun causes weight *I* at the outer end of the spiral to unwind this ribbon, with the result that the space between washer *F* and head *G* is left clear. Now the only resistance to inward movement of the firing which would allow it to contact with fulminate cap *J* is the safety pin *E* that passes through cross-holes in the firing pin and cap. This safety pin is made of a wire of special composition, and its size has been carefully calculated in relation to the velocity of the shell, so that just sufficient cross-sectional area is provided to give pin *E* a slight excess amount of strength beyond that required to overcome the action of air pressure on the head of the firing pin, which is very considerable at the high muzzle velocity of the 3-inch field gun. Very little resistance is required by the body which strikes the head of the firing pin in order to cause the safety pin *E* to be sheared off and the shell to be discharged.

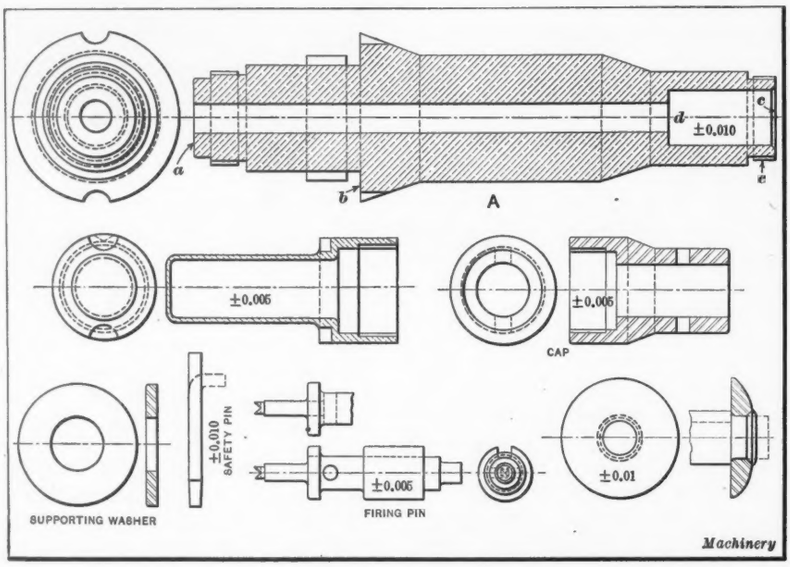


Fig. 2. Parts of Fuse for which Methods of Machining and Inspection are described

Progressive System of Ignition

After the safety pin *E* has been sheared, firing pin *D* moves inward to discharge cap *J* which is loaded with fulminate of mercury; the explosion of this cap results in igniting a second charge of fulminate carried in pocket *K*. Explosion of the fulminate carried in this pocket causes the bottom of the sheet-metal container in which charge *K* is carried to be destroyed. The explosive wave is communicated through the flash hole in the center of fuse body *A* to the charge *L*. The result is that charge *L* is detonated. Surrounding base *B*, in which charge *L* is carried, there is what is known as an "adapter" and "booster," that is, a threaded bushing which fits the base thread on the fuse body and is threaded itself on the outside to fit the thread which is machined in the nose of the shell. In this booster is carried a charge of T.N.T. (trinitrotoluol) which is exploded and in its turn causes the explosion of the main charge in the shell. From the preceding description it will be apparent that there are four primary explosions—each of which is of greater violence than the preceding one—and it is the stepping up of the violence by these successive explosions which is responsible for the high efficiency of this type of fuse and the great improbability that a shell fitted with such a fuse will fail to explode instantly upon striking its objective.

Rapidity of Action of Explosive System

Frequent mention has been made of the high efficiency of the French "seventy-five" in newspaper and magazine accounts of military operations in France. Attention has been called to the fact that this type of shell bursts instantly upon striking the ground so that the maximum amount of damage is done to men and materials in the vicinity of the point where the shell hits. This is in marked contrast to certain other types of shells which have a tendency either to bury themselves before exploding, or to ricochet off the ground before the shell bursts. In the Mark III fuse, the length has been so proportioned that head *G* of the firing pin strikes the ground a sufficient distance ahead of the shell so that all four primary explosions of charges in the fuse and

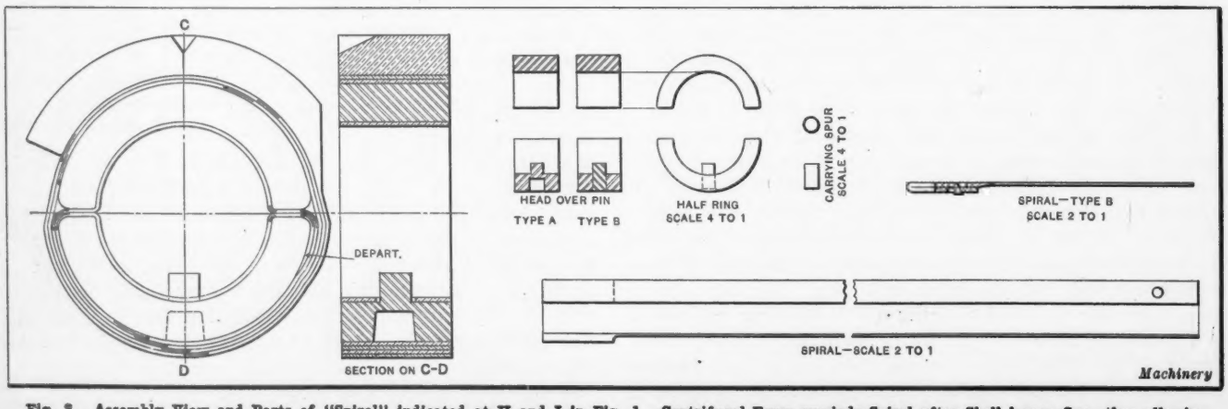


Fig. 3. Assembly View and Parts of "Spiral" indicated at H and I in Fig. 1. Centrifugal Force unwinds Spiral after Shell leaves Gun, thus allowing Firing Pin to explode Fulminate Cap in Fuse after Safety Pin has been sheared

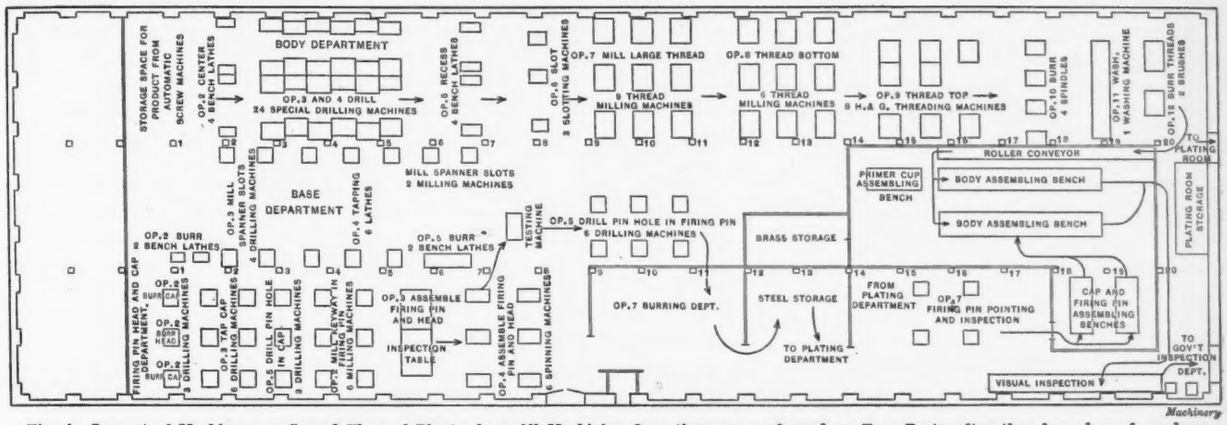

BODY DEPARTMENT
STORAGE SPACE FOR PRODUCT FROM AUTOMATIC SCREW MACHINES
OP.2 CENTER 4 BENCH LATHES
OP.3 AND 4 DRILL 24 SPECIAL DRILLING MACHINES
OP.6 RECESS 4 BENCH LATHES
OP.6 SLOT 3 SLOTTING MACHINES
OP.7 MILL LARGE THREAD
9 THREAD MILLING MACHINES
OP.8 THREAD BOTTOM
5 THREAD MILLING MACHINES
OP.9 THREAD TOP
8 H.& G. THREADING MACHINES
OP.10 BURR 4 SPINDLES
OP.11 WASH. 1 WASHING MACHINE
OP.12 BURR THREADS 2 BRUSHES
TO PLATING ROOM
ROLLER CONVEYOR
PRIMER CUP ASSEMBLING BENCH
BODY ASSEMBLING BENCH
BODY ASSEMBLING BENCH
PLATING ROOM STORAGE
MILL SPANNER SLOTS 2 MILLING MACHINES
BASE DEPARTMENT
OP.3 MILL SPANNER SLOTS 4 DRILLING MACHINES
OP.4 TAPPING 6 LATHES
TESTING MACHINE
OP.5 DRILL PIN HOLE IN FIRING PIN 6 DRILLING MACHINES
BRASS STORAGE
OP.2 BURR 9 BENCH LATHES
OP.5 BURR 2 BENCH LATHES
OP.7 BURRING DEPT.
STEEL STORAGE
FROM PLATING DEPARTMENT
OP.7 FIRING PIN POINTING AND INSPECTION
CAP AND FIRING PIN ASSEMBLING BENCHES
TO PLATING DEPARTMENT
TO GOV'T INSPECTION DEPT.
VISUAL INSPECTION
FIRING PIN HEAD AND CAP DEPARTMENT
OP.2 BURR CAP
OP.6 BURR HEAD
OP.8 BURR CAP
9 DRILLING MACHINES
OP.3 TAP CAP 6 DRILLING MACHINES
OP.5 DRILL PIN HOLE IN CAP 9 DRILLING MACHINES
OP.3 MILL SLOT WAY IN 6 MILLING MACHINES
OP.9 ASSEMBLE FIRING PIN AND HEAD
INSPECTION TABLE
OP.4 ASSEMBLE FIRING PIN AND HEAD 6 SPINNING MACHINES
Machinery

Fig. 4. Lay-out of Machinery on Second Floor of Plant where All Machining Operations are performed on Fuse Parts after they have been formed on Automatic Screw Machines located on Ground Floor. Attention is called to "Stream-line" Routing of Work through Plant to avoid Unnecessary Handling

booster take place and enable the main charge carried in the shell to be exploded before the shell has had time to enter the ground. In this way the force of the explosion is not expended in forming a crater, but is effective in giving a high velocity to the fragments of the shell.

Method of Handling Raw Material

There are four main parts of the fuse, namely, the body and base, which are made of brass, and the cap and firing pin, which are made of steel. The brass used contains approximately 60 per cent copper and 40 per cent zinc. Cold-drawn steel is used for making the cap and firing pin, because this material is of uniform size, so that it works well in the collet chucks of automatic screw machines, and there is no scale to damage the cutting tools. The brass bars used for making the fuse body are 1¼ inch in diameter and the bars from which the bases are made are 13/16 inch in diameter; the steel bars used for making the head of the firing pin are 7/8 inch in diameter, and the bars from which the caps are made are 13/16 inch in diameter.

Before starting to describe in detail the manufacturing methods which are used in producing fuse parts, a brief description will be given of the lay-out of the plant in order that readers may better understand the subsequent discussion of the way in which departments were organized to facilitate the work of manufacture and inspection as far as possible. The bar stock is received in a storage shed located on the railroad siding, and before being sent to the plant it is run through a pipe machine equipped with a suitable rotary cutter-head to provide for beveling the edge of each end of the bar, the purpose being to assure having all of the bars sent to the machine shop in such condition that they can be readily entered into collet chucks on the automatic screw machines. On its way from the storage shed to the machine shop the material is passed over a scale on which the weight is taken, and this weight is recorded in record books which are kept by the production department. This serves as a check on the invoices of the firms from whom the material is purchased.

Arrangement of Manufacturing Departments in Plant

After being weighed, the material enters the main part of the plant which is a four-story building. On the first floor the space is given over to National-Acme four-spindle automatic screw machines which are employed for roughing-out the fuse parts from bar stock. When this work has been completed, the parts are taken up to the second floor on which there is the necessary equipment for the performance of all manufacturing operations that are required to bring the automatic screw machine parts into condition for final assembly. The lay-out of equipment on this floor is shown in Fig. 4, where it will be seen that the machines used for finishing brass parts are set up on one side of the shop and the machines required for finishing steel parts are located at the opposite side. Arrows indicate the direction followed by the work in going from department to department, and it will be apparent that the ideal "stream line" method of routing has been carried out, with the exception of the one point where steel parts are taken out of storage and transferred to the plating room at the extreme end of the shop, where these parts are zinc-plated, and then brought back to the firing pin pointing machines. The reason for this departure from the theoretical stream line routing was that it was considered advisable to locate the plating room at the end of the shop where the acid fumes could be carried away with the least probability of their proving dangerous to the life of mechanical equipment or to the health of the employes.

Special Methods of Inspection

A large part of its success in manufacturing the Mark III fuse is attributed by the management of the plant of the International Steel & Ordnance Co. to the very complete method of inspection which has been inaugurated. Each part receives a 100 per cent inspection after the performance of each operation, with the result that all pieces which are found to be defective after any operation is completed, are immediately separated from the regular product in course of manufacture, thus saving the cost of subsequent machining operations on

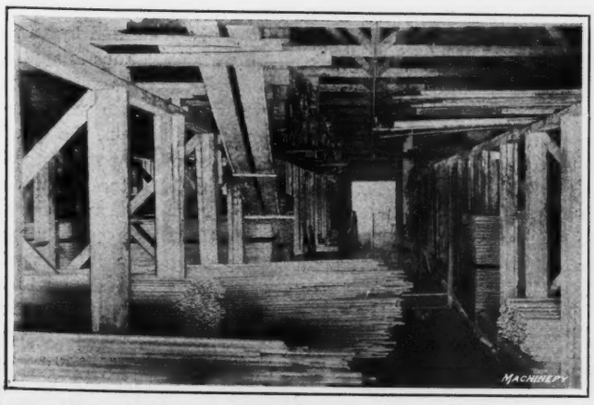


Fig. 5. Storage Shed for Bar Stock. This Shed is built on Railroad Siding with its Door opposite Door of Receiving Room in Main Factory Building

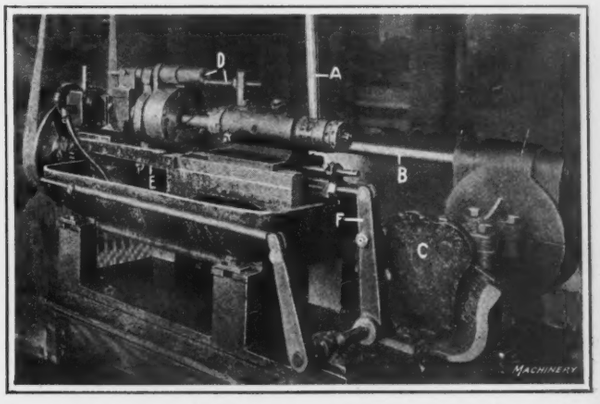


Fig. 6. Threading Machine equipped with Special Draw-back Collet which holds Work in Accurate Alignment, and Self-opening Threading Die of Standard Design

worthless parts. In connection with this work of inspection, mention must be made of the third floor of the plant, a part of which is given over to the reclaiming of parts that the inspectors have found to be defective. It goes without saying that pieces found to be undersize must be rejected, but in cases where parts are above the required size, and where certain other troubles, such as eccentricity of threads, etc., are discovered, it is generally possible to locate the trouble and bring the parts into such a condition that they will pass the most rigid inspection. So efficient has this combined system of inspection and reclamation proved itself that after all of the defective parts have been corrected, where possible, the amount of spoiled work due to errors in machining has averaged less than 2 per cent on a daily production of approximately 28,000 fuses. In a later section of this article detailed information will be given concerning the method of inspection and the special types of gages which are employed.

TABLE 1. MACHINING OPERATIONS ON BODY OF MARK III FUSE

Operation Number	Operation	Type of Machine	Type of Tool
1	1st Position — Form base end; start forming and center front end	No. 56 National-Acme four-spindle automatic screw machine	Forming tool, box-tool, and center drill
	2nd Position — Finish forming, drill, and turn for thread at front		Box-tool, drill, and forming tool
	3rd Position — Finish-form base end and shave to length; face end and ream hole		Shaving tool, box-tool, and stepped reamer with facing tool
	4th Position — Cut off from bar		Cutting-off tool
2	Center-drill base end	Rebuilt Cataract bench lathe	Center drill
3	Drill flash hole half way through body	Special semi-automatic drilling machine with pneumatic feed	Twist drill
4	Finish drilling flash hole from opposite end	Same type of machine as for Operation 3	Twist drill
5	Turn recess behind thread at front end	Cataract bench lathe	Lathe tool
6	Mill spanner slots	Special milling machine	Milling cutters
7	Mill thread on large diameter at base end	Holden-Morgan thread milling machine	"Hob" type of thread milling cutter
8	Mill thread on small diameter at base end	Holden-Morgan thread milling machine	"Hob" type of thread milling cutter
9	Cut thread at front end	H. & G. thread cutting machine	Acme self-opening die
10	Burr recess at front end and both ends of flash hole	Goodell-Pratt polishing heads	Piloted burring tool
11	Wash to remove grease	Special washing machine	Oakite solution

Machinery

Special Machinery Used in Manufacturing Fuse Parts

The International Steel & Ordnance Co. took a contract for the manufacture of Mark III fuses for the United States Government after it had completed work on a contract for Russian fuses. Experience gained in handling this work showed that standard types of machine tools were in many respects deficient for dealing with the peculiar requirements that have to be fulfilled in manufacturing fuses. On this account, it was decided to design and build many special machines for performing those operations which could not be handled in an expeditious manner on machines of standard design. In other cases, certain features of the design of standard machines were modified.

Drilling Flash Hole in Fuse Bodies

In Fig. 8 is shown a special semi-automatic drilling machine with pneumatic feed which was designed and built in the factory for use in drilling the flash hole in fuse bodies. Originally this operation was performed on bench lathes equipped with a collet chuck for holding the work and a long hand-lever for traversing the turret saddle along the bed to provide for feeding the drill into the work. A great many girls are employed as machine operators and they are all engaged on a piecework basis. Many of these girls have developed into exceptionally efficient operators, but their knowledge of the conditions under which different tools should be operated is naturally quite limited. The incentive to make as much money as possible naturally led these girls to push the drills to the limit, with the result that many drills were broken. It was to overcome this item of expense through breaking of twist drills that the special machines were designed, and in addition to accomplishing this result they have been the means of effecting a substantial increase in production.

How the Machine Operates

Stated briefly, the operation is as follows: The work is held in an air-operated collet chuck and the drill is fed into the work by pneumatic pressure. An automatic reversing device is provided for the pneumatic feed mechanism, so that the drill is alternately fed into the work and backed away to clear chips from the hole. In this way, there is no danger of chips binding the drill and causing it to be broken. The collet chuck is of the draw-back type, and is operated by an air valve *A* that governs the direction in which pressure is applied against the piston in cylinder *B*. Throwing this valve lever in one direction causes the chuck to close on the work, and when the lever is thrown in the opposite direction, the chuck is opened so that the drilled piece may be removed and a fresh blank substituted. When the lever is brought to the middle or neutral position, air is shut off from the cylinder.

Geared to the headstock there is a shaft *C* which runs along the front of the machine; at its right-hand end this shaft carries a three-lobed cam *D* that actuates the valve which governs the reciprocating feed movement of the drill. The valve used for this purpose is the familiar type of slide valve used in locomotive engines. It is contained in a case shown at *E*, and the valve is operated in the following manner: Pivoted lever *F* carries a roller at its lower end which runs over the three-lobed cam *D*, while the upper end of the lever engages pin

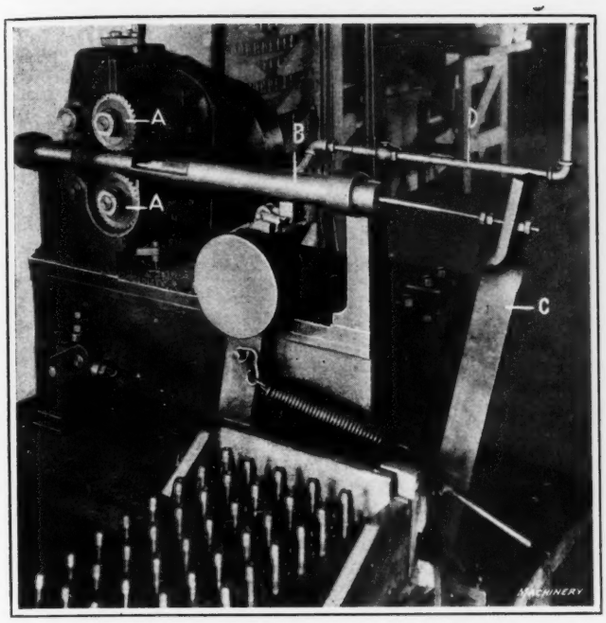


Fig. 7. Special Milling Machine used for cutting Key-slots in Fuse Bodies. The Operator simply drops Fuse Body into Feed-tube, after which Collet automatically grips Work and feeds it past Cutters

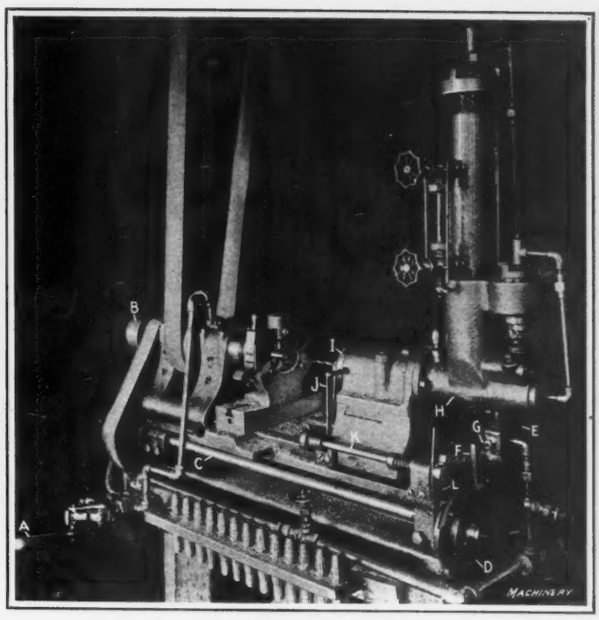


Fig. 8. Special Horizontal Drilling Machine designed for drilling Flash Hole in Fuse Bodies. This Machine is equipped with an Air-operated Collet and an Automatically Controlled Pneumatic Feed Mechanism for the Drill

G which is connected to the valve. Spaced around the cam at intervals of 120 degrees there are three depressions into which the roller carried by lever F drops, thus allowing the valve to be pushed over by spring tension, which results in shutting off air from the back of the piston in cylinder H and admitting air at the opposite side of the piston to provide pressure for withdrawing the drill from the work to clear it of chips. This return movement of the drill is quickly accomplished, after which the roller carried by lever F runs up onto the higher level of the cam, once more reversing valve E to shut off air at the front of the piston and admit it at the opposite side of the piston to provide pressure for again feeding the drill into the work.

Automatic Stop for Feed Movement

There is an automatic pressure regulating device on cylinder H, which governs the rate of feed so that it is suitable for the size of drill and material which is being machined. The reciprocating feed and return movements of the drill are continued until the hole has been drilled to the required depth. When this result has been accomplished, further movement is stopped by the following means: At the front of the cylindrical shaped slide that carries the drill, there is a cam groove which runs parallel to the axis of the slide up to a point near the inner end of the groove where a sharp turn is made. Carried on the inside of collar I, through which the drill slide moves, there is a roller that runs in this cam groove; and at the same time that the drill has reached the desired depth in the work, this roller comes to the turn in the cam groove. This causes collar I to be rotated, with the result that the arm extending out from this collar lifts link J and imparts an oscillating movement to horizontal shaft K. At the right-hand end of shaft K there is a catch L which has a notch cut at its lower end, and oscillation of shaft K causes this catch to be swung inward so that the notch engages a pin carried on the inner side of cam D, stopping rotation of the cam through the slipping of a frictional connection between the cam and shaft C. In this way, feeding of the drill is stopped and the operator then releases the drilled piece of work from the collet by pushing over lever A. A new blank is then substituted and the collet closed, after which the top of catch L is pushed inward to release the catch and allow the feed mechanism to be started again.

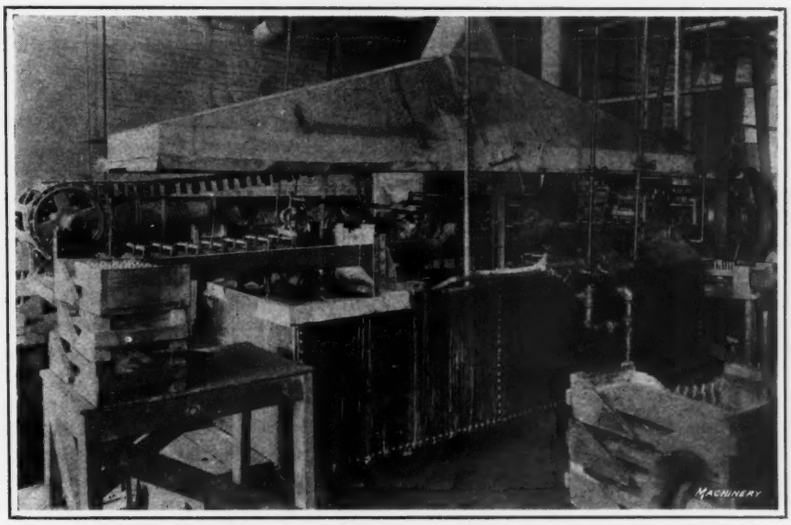


Fig. 9. Washing Machine built for Use in cleaning Fuse Bodies. A Conveyor carries Work through Hot Oakite Solution, over Tampico Brush sprayed with Hot Oakite Solution, through Cold Water Dip to precipitate Grease, and, finally, through Hot Water Bath which heats Work sufficiently so that it dries without requiring Application of Heat

Machine for Milling Spanner Slots

For use in milling spanner slots in the body of the fuse, a special milling machine was developed which is shown in Fig. 7. Two slots are milled at opposite sides of the fuse body, and to provide for milling these slots simultaneously two milling cutters A are provided on the machine. Contained in tube B there is a collet chuck which has a continuous reciprocating movement imparted to it by means of lever C which oscillates back and forth through the action of a cam mechanism inside the bed of the machine. The collet is open when in its backward position, and the operator simply drops a fuse body into the opening in tube B and pushes it back into the collet. The cams which impart the oscillating movement are so designed that lever C remains stationary for some time while in its backward position, and as the lever moves forward it pushes a tapered bushing over the outside of the collet. This causes the collet to close and grip the work during the time that the work is pushed forward through tube B to provide for feeding it between cutters A which mill the spanner slots. The fuse body is fed head first between the cutters, and. after pass-

ing them, a spring clip in tube *B* rises up behind the square shoulder on the fuse body, so that it is prevented from being drawn back as the collet is opened and starts to return. When a second fuse body is put into the collet and fed between the cutters, this body pushes out from the left-hand end of tube *B* the one in which the spanner slots were milled during the preceding operation. Pipe *D* is connected with the compressed air line and its lower end enters tube *B* so that any chips which may be drawn back by the collet during its return movement may be blown out.

Special Equipment for Threading Machine

On the fuse body, thread milling machines are used for cutting both of the threads at the base end, but H. & G. threading machines equipped with National-Acme self-opening dies are used for cutting the thread at the head end of the fuse, onto which the cap is screwed. One of these machines is shown in Fig. 6. In order that the cap and body of the fuse will assemble properly, this thread must be perfectly concentric and it must also be cut square with the shoulder. The H. & G. threading machine is ordinarily furnished with a collet of the type which is closed by a push-bar, but when this kind of collet was used for threading fuse bodies, it was found that owing to the peculiar nature of the work there was a tendency for the piece to be cocked slightly out of line, with the result that the thread was likely to be cut both eccentric and out of square with the shoulder against which the cap is screwed up. To overcome this difficulty, a special collet was made to operate with a draw-bar; and with a collet of this type, the fuse body is put into place and drawn back, so that the shoulder on the work comes up snug against the nose of the collet and assures having the work properly held to cut the thread both concentric and square with the shoulder.

In operating this machine, the collet is closed by turning lever *A* which controls the operation of a cam mechanism that draws back the collet. A special feed mechanism is also provided on the machine, which is driven by gearing it to the headstock. This connection is made by a gear carried on a quadrant which enables this gear to be swung into mesh with either the driving or driven gear on the headstock to provide for obtaining rotation of the threading die in opposite directions for cutting right- or left-hand threads. The drive is carried back through shaft *B*, and thence through a worm and worm-wheel to cam *C* which actuates the feed. Different cams are provided for cutting threads with different leads. These cams are laid out to provide for a quick advance of the work to a point just before it is engaged by the die, a uniform feed of the work into the die until the thread has been cut to the required length, a quick return of the work after the die has opened automatically, and a dwell of sufficient length to allow the threaded fuse body to be removed from the collet and a fresh blank substituted. Two stops *D* come into engagement when the thread has been cut to the required length, after which the die is tripped. On the return movement rod *E*, which is connected to lever *F* carrying the cam roller, closes the die ready for the next threading operation.

Washing Finished Fuse Bodies

Before being sent to the assembling department, it is necessary for the fuse bodies to be thoroughly washed, and for this purpose use is made of a special washing machine shown in Fig. 9. This machine is equipped with an endless chain conveyor furnished with pairs of lugs carrying a fixed and a sliding center, respectively, between which a fuse body is held. The sliding center is pushed forward by a spring after the fuse body has been put in place between the centers. After being set up at the left-hand end of this machine, the work is first carried down into a compartment containing hot oakite solution, and then passes up from this compartment of the washing machine in such a way that each fuse body goes over a rotating tampico brush onto which hot oakite solution is constantly sprayed. This double treatment results in removing practically all of the dirt and grease from the work. After receiving this treatment, the work is passed through a second compartment of the machine containing cold water, the object being to precipitate any loose particles of grease and dirt which still adhere to the fuse bodies. Then the conveyor carries the work up over the partition which separates the compartment filled with cold water from a third compartment containing hot water. The purpose of passing the clean fuses through this hot water is to raise their temperature sufficiently so that water adhering to the work will be rapidly evaporated after the work is removed from the washing machine.

The preceding operations complete the work on the body. In the next and concluding installment of this article, the operations on the base, cap, and firing pin, and the methods of inspection, as well as the gages used, will be dealt with.

* * *

NATIONAL EMPLOYMENT SERVICE

In accordance with the decision of the War Labor Policies Board, approved by the President on June 17, the supplying of war industries with common labor has been centralized in the U. S. Employment Service of the Department of Labor, and all independent recruiting of common labor by manufacturers having a payroll of more than 100 men must be diverted to this service. While the restrictions against the private employment of labor apply only to common labor at the present time, these restrictions will, as soon as possible, be extended to include skilled labor. In the meantime, recruiting of skilled labor for war production will be subject to federal regulations now being prepared.

This change in the nation's labor program has been found necessary in order to protect the employer and the employed, to conserve the labor supply of the communities, to cut down unnecessary and expensive labor turnover (which in some cases is as high as 100 per cent a week), and to increase the production of essentials. While non-essential industries will be drawn upon to supply the necessary labor for war work, the withdrawal will be conducted on an equitable basis in order to protect the individual employer as much as possible.

Under the operating methods adopted, the country has been divided into thirteen federal districts, each district being in charge of a superintendent of the U. S. Employment Service. The states within each district are in turn in charge of a state director, who has full control of the service within his state. In each community there is being formed a local board, which will have jurisdiction over the recruiting and distributing of labor in its locality. A survey of the labor requirements is being made, and in order that each community may be fully protected, no labor may be transported out of any community by the U. S. Employment Service without the approval of the state director, nor shall any labor be removed by the Service from one state to another without the approval of the U. S. Employment Service at Washington. Every effort will be made to discourage any movements from community to community or from state to state.

The requirement that unskilled labor must be recruited through the sole agency of the U. S. Employment Service does not at present apply in the following five cases: Labor which is not directly or indirectly solicited; labor for the railroads; farm labor, which is to be recruited in accordance with existing arrangement with Department of Agriculture; labor for non-war work; labor for establishments the maximum force of which does not exceed one hundred.

When the survey of labor requirements has been made, each state will be assigned a quota, representing the common labor to be drawn from among men engaged in non-essential industries in that state; these state quotas will, in turn, be distributed among localities. Within each locality, employers in non-war work and those who are only partially in war work will be asked to distribute the local quotas from time to time among themselves. The object is to keep any community from being drained of labor and to use the local supply, as far as possible, for the local demand. The absolute necessity for this program can be seen when it is realized that in Pittsburg, for instance, there are advertisements calling for men to go to Detroit, while in Detroit street cars there are posters asking men to go to Pittsburg. This same condition is apparent all over the United States, and in the consequent shifting of labor a great part of our war effort is dissipated; hence, the importance of the steps taken.

HOLLINGS INDENTING TYPE OF NUT-FORGING MACHINE

A MACHINE WHICH IN CONJUNCTION WITH THE SPECIAL BAR STOCK USED, MAKES IT POSSIBLE TO PRODUCE WELL-FORMED BLANKS WITHOUT EXCESSIVE PRESSURE AND WITH A RELATIVELY SMALL AMOUNT OF SCRAP

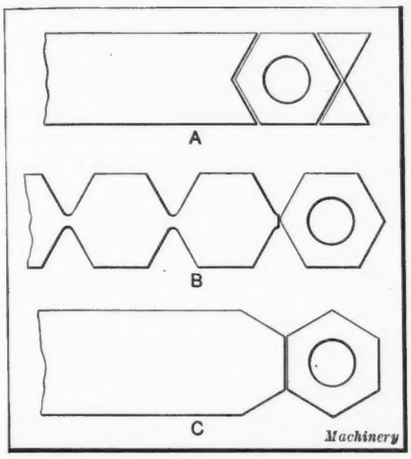


Fig. 1. Three Methods of forging Nuts

IN forging nuts, it is desirable to produce well-formed sharp-cornered nut blanks without subjecting the machine to excessive stresses, and also reduce the waste or scrap to a minimum. The common method of forging nuts is illustrated at *A*, Fig. 1. The nuts are cut or sheared from the end of the heated bar of rectangular stock and then the hole is punched in the blank. With this method, there is considerable waste, the slug which is removed from the center to form the hole and the triangular-shaped pieces which are cut from the bar between successive blanks, being scrap. In order to reduce the amount of scrap, attempts have been made to use bars of stock having V-shaped notches rolled into them, as indicated at *B*, instead of cutting away the stock and thus removing the triangular shaped pieces. Another plan that has been tried is shown at *C*. In this case, the V-shaped notches are formed by indenting tools on the nut-forging machine, which compress the metal on each side of the bar. Both the notched bar method and the use of indenting tools have been tried extensively during the past thirty years in the United States, England, and Germany. The use of notched stock and of indenting tools on the forging machine were both unsuccessful, partly because the machines were faulty in design and did not operate satisfactorily. When using notched bars, the entire bar of stock would usually be spoiled if one nut were spoiled. The indenting type of forging machine that formerly was experimented with also proved unsatisfactory, as stock of rectangular section was used and the indenting operation distorted the nut blanks so much that the pressures necessary to form sharp-cornered blanks were beyond the limit of endurance of both the tools and the machine.

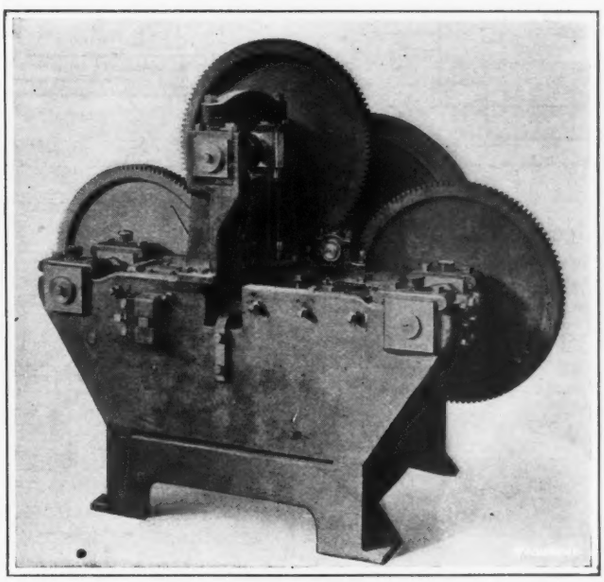


Fig. 2. Hollings Nut-forging Machine

General Description of Nut-forging Machine

The nut-forging machine illustrated in Fig. 2 represents a recent development which, in conjunction with the special shape of stock used, makes it possible to produce well-formed blanks without excessive pressures and with much less waste in the form of scrap. In fact, it is claimed that the consumption of stock in an ordinary nut-forging machine operating on the principle illustrated at *A*, Fig. 1, may be as much as 50 per cent greater for the same production of nuts than in the indenting type of machine to be described. It is further claimed that the saving in material will equal the initial cost of the machine in less than six months. According to production figures, 3200 pounds of stock were required by the old method to produce 10,000 ¾-inch hexagonal nuts, there being 1100 pounds of scrap. By the new method only 2300 pounds of stock were required for the same number and size of nuts, there being only 200 pounds of scrap. In this case about 40 per cent more material was required by the old method.

A sectional view through the center of the machine and a plan (with indenter bracket removed) are shown in Fig. 4. The machine is driven by shaft *A* upon which is mounted a flywheel and tight and loose belt pulleys. This shaft carries a driving pinion *B* which meshes with gears *C* and *D*. The latter is mounted on the end of crankshaft *E*, which is connected with and operates the main cut-off slide *F* by means of a double or divided pitman *G* and G_1. In the center of the cut-off slide *F* is the slugger block *H* to which is attached punch *I* for thinning and ejecting the slugs from the cutting-off punch when the machine is in operation. This slugger block is operated by two hardened steel inserts (one of which is shown at *J*) dovetailed to an enlarged section in the center of the crankpin.

The slide *K* to which the crowning tool is attached is actuated by a pair of cams on shaft *L*. The block *M* which carries the piercing punch *V* is mounted in the center of the crowning-tool slide, the construction being similar to the cut-off slide and slugger block on the opposite side of the machine. Shaft *L* carries a gear *N* which meshes with gear *C*. The gears *N*, *C*, and *D* are of the same size, so that the three main shafts of the machine run at equal speeds.

The indenting tools *O* and *P* receive their motion from a cam on shaft *Q*, the bearings of which are supported by a heavy frame extending above the main bed of the machine. As the slide carrying indenting tool *O* is forced downward, the lower tool *P* is drawn upward by means of a yoke *R* which is connected by tie-rods with a similar yoke to which the lower indenting tool is attached (see also the detailed view, Fig. 5). The two yokes are located in a diagonal position and the tie-rods pass through holes in the bearings of shaft *Q* and also through bushed bearings in the machine bed which serve to steady the frame consisting of the yokes and the tie-rods that connect them.

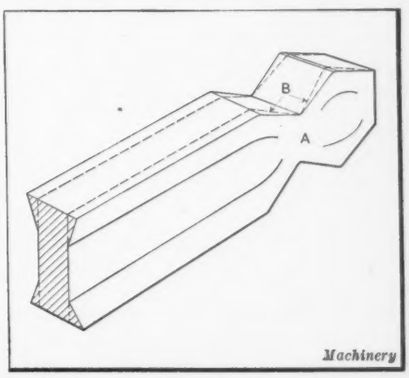


Fig. 3. Special Patented Shape of Bar used in Conjunction with Hollings Nut-forging Machine

Operation of Machine

In the operation of this machine, the heated bar of stock is fed in from the side and the V-shaped notches are first formed by the indenting tools *O* and *P*. The cutting-off tool *S*, Fig. 4, then moves up, severing

a blank which is pushed into the die *T;* then punch *I* advances rapidly and thins the slug as the stock is forced against the opposite punch *V* which also expands the blank in the die *T*. Punch *I* then recedes and the nut is compressed against the crowning tool *U*. The hole is next pierced as punch *V* continues its stroke, the slug being forced inside the cutting-off tool *S*. The tools *S* and *V* now recede and as the crowning tool *U* is advanced by cams on shaft *L*, the nut is pushed out of the die. When the cut-off tool *S* moves backward, the slug is ejected by punch *I*, and at the same time the nut blank is ejected by the nut kicker *W*. The latter has a diagonal motion downward and outward, which insures the nut being removed from the crowning tool, as it passes clear across the face of the tool.

Special Form of Bar Stock Used

The special form of bar stock used in conjunction with this machine is illustrated by the perspective view, Fig. 3. The central part of the bar is of rectangular section, but the ends flare outward as the illustration shows. The object of using this special shape is to make it possible to secure well-formed sharp-cornered nut blanks and still keep the necessary pressures within commercial limits—not simply experimental limits. While it is possible to make nuts by the indenting method when using stock of plain rectangular section, such a severe blow is required that the method is impracticable as a commercial proposition. The rolling of the section illustrated in Fig. 3, therefore, is the first step in this patented process of nut forging. When the machine is operating on a bar of this shape, the indenting tools, in compressing the metal, force it outward, thus filling up the narrower section at *A*. The result is that the sides of the nut blank are approximately flat, except in the center, where the hole is to be pierced; consequently an excessive blow or pressure is not necessary in flattening the nut. When an attempt is made to form nuts from plain rectangular

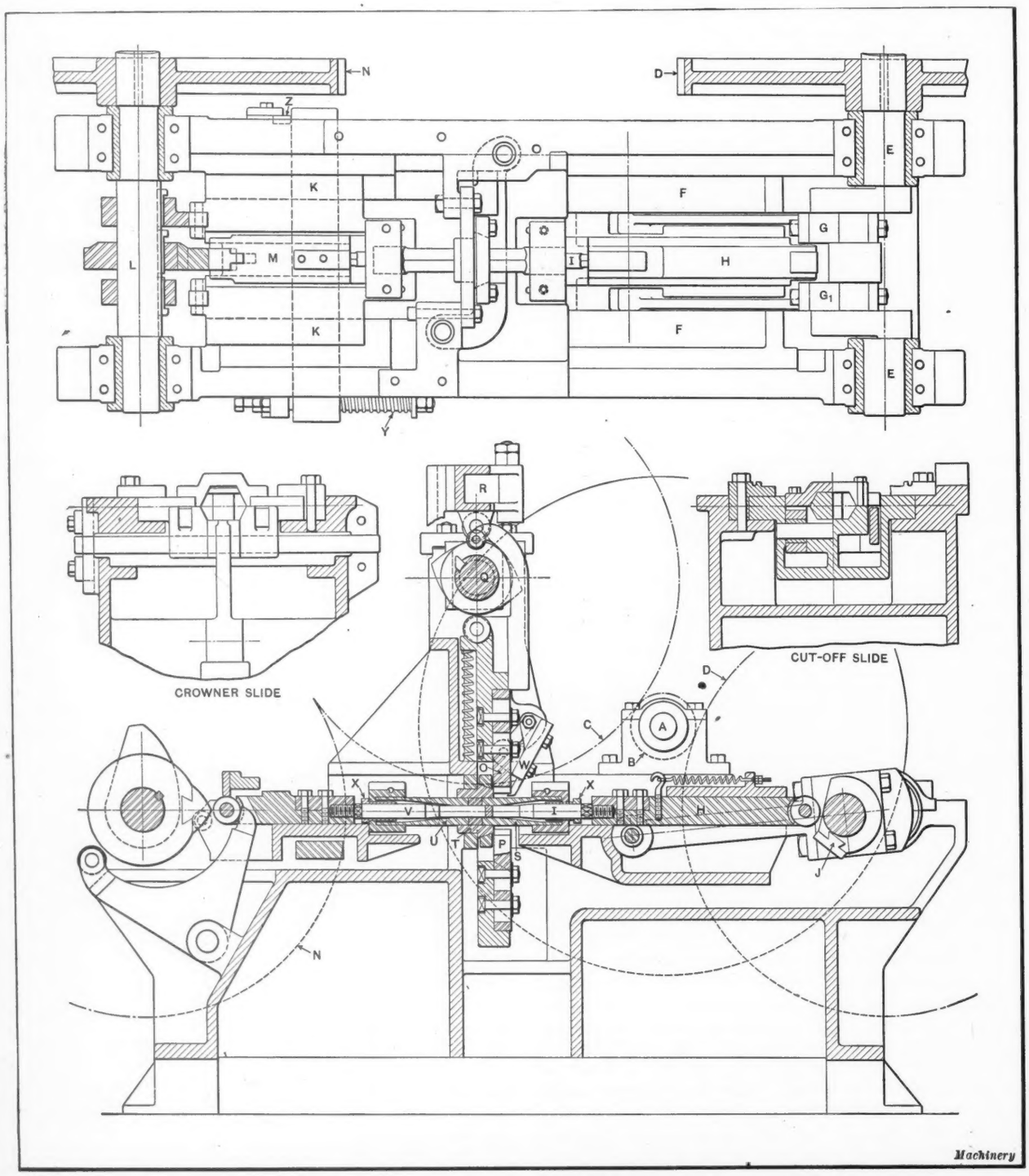


Fig. 4. Sectional and Plan Views of Nut-forging Machine equipped with Indenting Tools

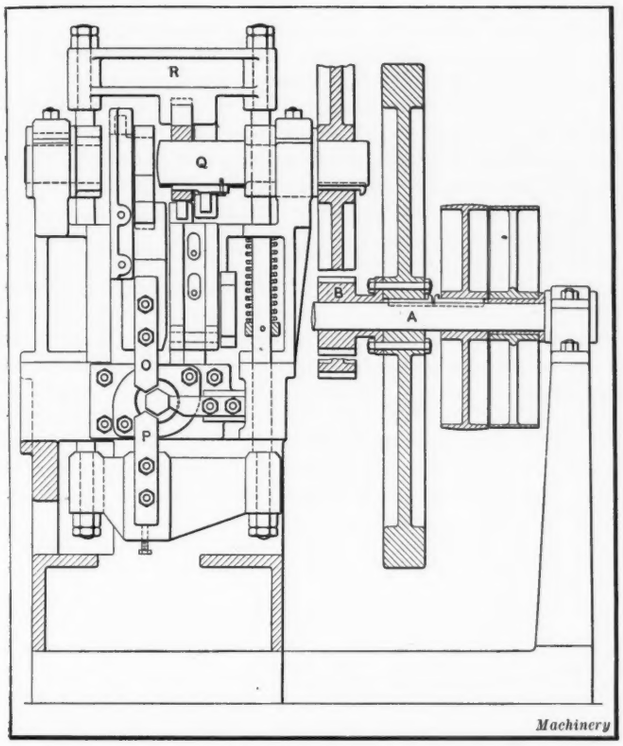


Fig. 5. Detail View of Indenting Tools and their Operating Mechanism

stock the indenting tools force the metal outward as indicated by the dotted lines at *B*. The result is that the blank is narrow at the top and bottom and the machine is subjected to severe stresses while forming the blank.

Important Constructional Features

The cutting-off tool is held positively in its holder instead of depending on a friction grip. The punch *I*, Fig. 4, for ejecting the slug and the piercing punch *V* are provided with adjustable brass sleeves *X* which are free to slide through the rear ends of the respective tool-holders, so that by piping the water to the hollow space within the crowning and cutting-off tools, water is pumped through these spaces by the action of the machine, thus cooling the tools and increasing their durability.

The driving pinion *B* is secured to the flywheel by two bolts as shown in Fig. 5, so that if a cold bar should be placed between the indenting tools, the bolts will shear off and prevent damage to the gears or other parts of the machine. The main thrust of the machine is exerted against a thrust bar which passes straight through the machine. One end of this bar is supported by spring *Y*, Fig. 4, and the other end bears against a small cross-bar *Z* which acts as a safety breaker in case two nuts should accidentally get into the die. The tension of spring *Y* can be regulated to give the correct pressure. The machine is so designed that the principal members are subjected to almost a plain straight tension, the twisting and side strains having been reduced to a minimum. The strain resulting from the indenting operation is also taken by the vertical tie-rods previously referred to, and throughout the entire machine the strains are largely balanced. The bearings are so located that they are protected from the water and scale, which is considered an important feature as most of the trouble and breakdowns on horizontal forging machines are due to excessive wear and tear on the slides, resulting from the scale and water. Special attention has been given to the lubricating system which is a combination of the ring-oiler, plain reservoir, and dash systems. This machine may be used on rectangular stock, the same as the ordinary center-feed type, by simply removing the indenting tools. This process of forging nuts, including the machine and the special form of bar, is covered by over thirty patents which have been granted in most countries throughout the world. Ernest Hollings, 5 Kelvin Ave., Sale, Cheshire, England, is the inventor, and the process is operating on a commercial basis in Manchester, England.

SUGGESTIONS FOR PACKING MACHINERY FOR EXPORT

The General Engineering Depot of the War Department publishes the following suggestions for specifications for packing machinery, supplies, and equipment for export on orders issued by this depot:

All merchandise must be protected by substantial boxing and must be securely packed therein; export shipping conditions involve much rougher handling than is usually understood. All packing should be as light in weight as possible and cubic contents kept to a minimum in order to economize in shipping space; but the paramount consideration must always be safe handling.

Packages over 1000 pounds or less than 200 pounds should be avoided when practicable. Each case or crate should be firmly bound with strap or band iron not less than 1 inch wide and No. 18 gage; the ends should overlap at least 6 inches. All lumber used in boxing and packing should be strictly sound and of such dimensions as to insure full protection under rough handling. Under no circumstances should outside boxing be less than 13/16 inch thick. Boxes weighing 600 pounds or over should have 4- by 4-inch skids at the top and bottom. These should be securely bolted together with ⅝-inch diameter bolts, which, wherever possible, should extend entirely through the box. To prevent shifting, the ends of the box must be securely braced inside. Use corner posts in all packages.

The machinery itself should be covered with waterproof paper or oilcloth to prevent damage from moisture after having first been thoroughly slushed with some suitable protective compound. All loose or detached parts should be securely fixed to prevent dislodgment during transit, and all finished surfaces should be amply protected against injury from salt air and water. Packages containing machinery or parts should be securely blocked in the case or crate to prevent any movement.

Electrical and mechanical apparatus should be solidly packed in excelsior, straw, salt hay, or other filler in a solid box with paneled ends, securely nailed, and then reinforced with ⅞- by 3-inch battens around the sides at the ends, with 1-inch, No. 18 gage, strap iron all the way around the battens, ends lapping at least 6 inches. Tools, instruments, or any articles subject to damage by moisture should be well wrapped in waterproof paper and placed in boxes thoroughly lined with waterproof paper. On heavy boxes, sling marks are to be plainly indicated on the outside at the proper place and reinforcement must be provided to insure against damage to the case. All wide-side pieces of flat packages should be prevented from splitting by cross-pieces nailed to them—one in the middle for pieces 6 feet long and two for sides over 6 feet; band iron or corner clips at the top and bottom should connect at these cross-pieces. If new packing is tried, the boxes and crates should be tested by forcibly pushing each over the end twice and then dropping the package from a platform 3 or 4 feet high; the package must not be broken to any extent by this test.

Projecting portions of heavy castings having narrow necks must be taken off, as they may break off by jarring. Gray-iron extended parts must be kept from ½ to 1 inch away from the covering, as the spring of the boards may cause breakage. Two heavy cast pieces must not rest together, but must be cushioned or separated by a wooden brace or block. In packing machines that are knocked down it is desirable to indicate, "Open on this side." Heavy items must be firmly bolted to skids or flooring; nothing should be hung from the sides of a box. Unoccupied space in packing boxes must be thoroughly braced.

In marking packages, waterproof marking or stencil paint should be used. There should also appear on each package a list of the contents, cubic contents, gross weight, and by whom shipped. Packing lists must be made out correctly and in detail with all the information called for. Merchandise must be described in specific terms; such designations as "hardware," "machinery," or any other general terms, must not be used.

ALIENS AS DEPENDENTS

BY CHESLA C. SHERLOCK[1]

The question as to who are dependents under the workmen's compensation acts is always interesting, but perhaps the most interesting question at the present time is the status of alien and non-resident dependents. Thousands of foreign-born workmen are employed in our steel mills, foundries, power plants, mines, and factories. Many of these have left their relatives and families in the homeland and intend, when they have saved sufficient money, either to return to their native land or have their relatives come here. The question, therefore, very naturally arises: Are those dependents entitled to compensation if the workmen should be killed or injured while working in this country?

In a California case, it was contended that no public purpose was to be served by requiring payments to such aliens and non-residents. The court held that this argument was based upon altogether too narrow a view, and said:

> If it may reasonably be thought that the best interests of the state, of the employers of labor, and of those employed, as well as of the public generally, are promoted by imposing upon the industry or the public the burden of industrial accident—and some such theory lies at the bottom of the workmen's compensation statutes—the residence and citizenship of the injured workman, or (if he shall have met death) of his dependents, are factors entirely foreign to the discussion. The legislature has determined that the employment of labor in given pursuits entails upon the employer certain responsibilities toward the persons performing the labor and those dependent upon them. There is no constitutional or rational ground for limiting the benefits of this legislative scheme to citizens or residents of this state. If the employment was such as to fall into the state's law making jurisdiction, the legislature certainly had the power to pass laws operating uniformly upon all persons affected by such employment.

One judge very vigorously dissented from this view which the majority of the court took. He said:

> I dissent from the view which justifies the giving of the property of a citizen of this country to non-resident aliens who are not even within the jurisdiction of the state. By no conceivable stretch of the imagination of which I am capable can I perceive that the support of such non-resident aliens is any part of the duty of the state, or that provision for such support comes within any possible legitimate purview of the police power.

Theory Underlying Compensation Acts

Compensation acts are based upon the theory that if an accident takes place in a factory, for instance, society should contribute toward the support of the injured workman, society having contributed toward his injury and having had the benefit of his labor during the time preceding his incapacity. At common law, it was customary to determine who was to blame for the accident and then assess the damages as soon as the guilt had been determined. Under the compensation acts, we are not concerned with the fault of the injured person, unless it is shown that he was injured by his own serious and wilful misconduct. All we want to know is whether the accident arose out of the workman's employment. If so, the fact that he is injured is sufficient to entitle him to relief.

It will be noted that this right to compensation is based upon a duty imposed by law; the sense of obligation fills the whole transaction. There would seem to be a duty owing from society to the dependents. But this duty does not seem so imperative where such dependents are residents of foreign countries and have never been in this country. Why should the employers of this country be compelled by our laws to divide their property with people who are not a part of our society, or of our state, nor have any interest whatever, save pecuniary, in this country? From a legal standpoint, it is perfectly proper to argue that our state owes no duty to the residents of a foreign country. The intention of the compensation acts was to provide and take care of those destitute dependents who are entirely dependent upon the injured workman, and who are likely to become public charges, if such aid is not imposed upon the industry causing the death. In no sense can the dependents of workmen living in a foreign country become public charges of this country, in case their relatives are injured or maimed here. There is no reason why foreign labor should be encouraged to come into this country for the purpose of acquiring money that it will later take away, and still enjoy the full protection of our social laws. In fact, if aliens and non-resident dependents were denied compensation absolutely, it would encourage such laborers to bring their families to this country and become citizens of this country, or else it would cause them to stay away entirely. This is a problem that the future must solve.

Non-residents not Entitled to Compensation

All the states do not take the view expressed by the California court. In Massachusetts, it was shown that the wife of a deceased workman had lived in a foreign country for a period of eight years, during which time her husband had sent her only $160. The court held that, under the Massachusetts law, this wife was not a dependent and therefore entitled to no compensation. In Kentucky, the act specifically provides that the compensation payable to non-resident dependents shall be just one-half that allowed to dependents residing in this country.

Many of the states have extended definitions setting out in detail, or so limiting, the word "dependent" that there is no chance for a non-resident or alien to obtain compensation. In other states, the requirement is that a wife, for instance, must be living with her husband in order to secure a compensation award. The courts have entirely spoiled this provision, however, by holding that for the purposes of the act a foreigner and his wife are living together, if he contributes something to her support, even if the wife is thousands of miles away in a foreign country and never has set foot on our shores. Employers are, of course, thoroughly acquainted with what constitutes dependency in the ordinary sense. There must be absolute dependence for support, there must be actual contributions toward such support, and the contributions must be made with reasonable frequency, so that they can be established and determined. Where no contribution toward the support of the dependents has been made, such persons are not, as a matter of law, dependent upon the workman, and compensation cannot be recovered.

Compensation to Residents of Turkey and Bulgaria

An unfortunate situation has arisen through the failure of the Federal Government to declare war upon Turkey and Bulgaria. Of course, it is impossible for a resident of Germany and Austria-Hungary to recover compensation for the death of a relative in this country, even though such alien were dependent upon such workman entirely for support. A state of war exists between these countries and the United States, and to award compensation to the resident of an enemy country would amount to nothing less than aiding and abetting the enemy. Bulgaria and Turkey are the allies of the countries that are trying to wipe out our civilization, yet awards of compensation are being made every day to the residents of those countries, just as if the friendliest of relations existed between them and us. There is no legal ground upon which such an award can be denied because war has not been declared against them. Of course, ways are sometimes found to postpone hearings and deny awards because the commissions sometimes cannot help but take into consideration the *de facto* side of the case. Certainly, no obligation to such aliens should repose in the commonwealth of any American state, and there is no valid reason why any alien who has never been in this country, who has never contributed anything to the common good, and who often is not even in sympathy with our country and its ideals, should be permitted to compel our citizens to divide their property with her, simply because she lost a husband or relative who came to this country "for the money there was in it."

* * *

The *Official Bulletin* states that, through slight changes in manufacturing processes, prevention of waste, etc., the price of rifles has been reduced approximately 35 per cent. At the beginning of the war, rifle companies considered $35 to $40 a fair price; now the rifles cost about $22 to manufacture.

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SAFE CHAIN LOADS

FACTORS THAT DETERMINE SAFE LOADS, AND EFFECTS OBTAINED BY ANNEALING CHAIN

BY A. BLACK[1]

THE sudden failure of hoisting chains when lifting loads much smaller than those specified in handbooks and by chain manufacturers as proper working loads may be explained by the stress theory. A careful examination of chains that have suddenly failed will reveal the fact that the fault is seldom due to a defective or burnt weld or to wear, but often to a condition of physical degeneration of the material which is usually ascribed to crystallization, although this physical change properly comes under the classification of fatigue. The term "fatigue" is used to embrace collectively the phenomena of deterioration of material due to continued stress beyond the elastic limit, to repeated shock or vibration caused by mechanical braking or slipping of the chain, to sudden or continued change of stress (even below the elastic limit), either of the same kind, as from one intensity to another, or of opposite kinds, as from tension to compression or the reverse.

Causes of Chain Failure

Failures of this nature are due chiefly to one or more of the following causes: rusting and abrasive wear; defective material or workmanship; erroneous method of computing maximum fiber stress and, therefore, safe loads; inherent error in accepted definition of safety factor; repeated or continued stressing of the material beyond its elastic limit, even though well below its ultimate strength, or otherwise inducing the condition of fatigue.

The significance of the qualities known as the ultimate strength, elastic limit, factor of safety, and maximum fiber stress, and the important part they play in determining a proper working load in any given case are not always appreciated, and apparently are not widely understood beyond the circles of research or testing laboratories. Engineers have frequently called attention to the unscientific and misleading, though practically universal, method of calculating the factor of safety by dividing the ultimate strength of the material by the imposed load or the induced stress. Since any continuous or repeated stress above the elastic limit, though considerably below the ultimate strength, will produce progressive fatigue, or deterioration and final rupture, it follows that any imposed load, to be safe, must not stress the material above the elastic limit. It is important to observe that this refers to the maximum fiber stress of the loaded material and not to the average stress. In practice, owing to the possibility of impact, shock, defective material or workmanship, or other unforeseen conditions that may induce accidental weakness, the safe load should be placed considerably below that limit. Hence, if the factor of safety is to convey any definite meaning as to real safety, it should be based on the elastic limit and not on the ultimate strength, as is the present usage.

Ultimate Strength of a Chain

The ultimate, or breaking, strength of a chain is usually found to lie between 1.5 and 1.7 (average 1.66) times the ultimate strength of the straight bar or stock from which it is formed, instead of twice that amount, as might at first thought be expected because of the doubling of the bar in forming the link. The difference is supposedly due to the effect of welding, permanent strain from bending, or other weakness. But the link of a chain under load is by no means in the simple physical condition of a bar under direct tension in a testing machine, or in a tension member of a roof or bridge truss. A link is subjected to a direct tension, due to the load or pull, and to a bending moment that induces tension on the outer fibers and compression on the inner fibers of that part of the link subject to bending. The stress in tension due to bending may equal more than three (for stud links) or four (for open links) times that produced by the direct pull evenly distributed over the cross-sectional area of the bars.

[1]Address: Care of General Chemical Co., 25 Broad St., New York City.

Stresses in Chain Links

As is well known, when a bar or rod is supported at its ends and loaded at the center, the effect of the load is to deflect the bar, inducing tensile stresses in the sections below the neutral axis, and compressive stresses in the sections above the neutral axis. Two equal opposing forces operating at the extremities will induce simple tension in the normal cross-sections of the metal. A combination of these cases is found in a chain link under stress. Every cross-section of the bent rod of the link up to a certain distance on each side of the central support is subjected to a bending stress and at the same time to a direct tensile stress. The actual total stress in any section of the metal is, therefore, the resultant of these two stresses, and only the maximum combination of the two is to be considered in any critical discussion of safe load, strength, or factor of safety. It has usually been assumed that the fiber tension produced by bending, as well as the effect of the weld, etc., is sufficiently provided for by the reduction of about 34 per cent of the ultimate strength based on the cross-sectional area of the doubled bar. On this general basis, with the introduction of an appropriate factor of safety, various tables of safe loads for chains have been computed and used in practice; but this reasoning is erroneous. While it is true that in testing a chain to the point of ultimate rupture the final failure does take place at the above intensity, and is usually due to simple direct tension on the sides of the link (which gradually straighten out as the imposed load progressively increases, the bending stresses being then no longer present), it is to be clearly noted that the elastic limit based on the maximum stress in the extreme fibers has been exceeded long before rupture takes place. In other words, this condition has been reached only after the safety of the chain has been jeopardized by overloading, a condition to which no chain should ever be subjected. That is to say, while this condition will occur in testing a chain to the point of failure, for scientific or other purposes, in actual use this point should never be reached or even approached.

Finding Safe Loads for Chains

The stresses in the link due to direct pull are easily determined by known methods. Heretofore, however, the difficulty has been to develop some method for determining the amount of stress in the link due to bending, as the maximum resultant of these two stresses is the only proper basis on which a table of safe loads should be computed. An investigation of these matters conducted at the Engineering Experiment Station of the University of Illinois, with a critical analysis of the results attained, affords a simple and convenient formula for ascertaining the actual maximum stresses in chains and links under specified loads due to combined pull and bending, and thus furnishes a reliable means of computing safe working loads for chains. This formula is:

For chains with open links of the usual form,

$$F = 2.5 \times \frac{P}{D^2}$$

For chains with stud links,

$$F = 2 \times \frac{P}{D^2}$$

in which F = extreme fiber stress in tension, in pounds per square inch;
D = diameter of stock, in inches;
P = chain load, in pounds.

The safe loads for open-link chains given in Table 1 have been computed by this formula, using the value of 12,000 pounds per square inch for the allowable maximum fiber stress, and assuming an elastic limit of 24,000 pounds per square inch, thus assuring in every case an actual safety factor of at least 2, based on the elastic limit of wrought iron, or more if open-hearth, low-carbon steel is used. For material

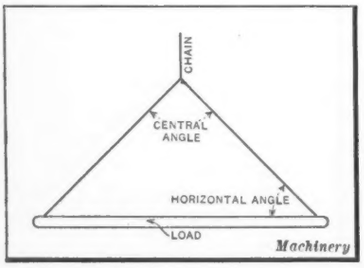

Diagram illustrating Angles mentioned in Table 1

possessing an elastic limit of 30,000 pounds per square inch, a fiber stress of 15,000 pounds per square inch may be assumed, in which case the tabular values should be increased 25 per cent.

The nominal size of a chain is indicated by the diameter of the steel or iron of the link. The central angle is the angle between the parts of a double sling; the horizontal angle is the angle between each part of a double sling and a horizontal line, as shown in the accompanying illustration. The horizontal collapsing force is the force tending to crush together the load carried between the points of attachment of a double sling. This force must be taken into consideration in the case of hollow castings and similar loads. It may be found by multiplying the total load by the factor given in Table 2. The safe values given in the table are for single chains. When used double, the values given should be multiplied by 2, and so on in proportion. In a double sling properly adjusted, each leg carries only its portion of the load; when a double sling is attached to a single chain of the same size, the safe load for the single chain only should be used. When a heavy chain is used in connection with a lighter double sling, the safe load is the smaller of the two tabular values; that is, it is either equal to the safe load of the chain that carries the total load, or to twice the safe load of one part of the sling, whichever value is the smaller.

Examples for Determining Safe Chain Loads

For example, a safe load for a single 7/8-inch chain is 3700 pounds. If this chain is used with a double 5/8-inch sling attached to the load so as to make a central angle of 15 degrees, each part of the sling has a carrying capacity of 1880 pounds, so that the double sling has practically the same safe load as the single chain, namely, $2 \times 1880 = 3760$ pounds. If a 1/2-inch double sling is used with this chain, and so attached as to make a central angle of 30 degrees, each part of the sling can safely carry only 1160 pounds, or a safe load for the double sling so attached is only 2320 pounds, which, being less than that for the straight chain itself, constitutes the safe load for the combination.

If a 1-inch chain is used with a 3/4-inch double sling making a central angle of 15 degrees, the double sling is capable of carrying a safe load of $2 \times 2675 = 5350$ pounds; but the straight chain itself can carry a safe load of only 4800 pounds, which is, therefore, the proper safe load of the combination. The collapsing or crushing force of this load is $0.06 \times 4800 = 288$ pounds. No controlling consideration has been given to the high compressive stresses existing on the inner ends of the links, for the reason that these excessive stresses are partly taken care of by the pinching action of the adjacent parts, as well as by lateral restraint.

TABLE 1. SAFE WORKING LOADS FOR SINGLE OPEN-LINK CHAINS [1]

For stud links increase these values 25 per cent

Diameter	Central Angle, Degrees								
	0	15	30	45	60	75	90	105	120
	Horizontal Angle, Degrees								
	0	82.5	75	67.5	60	52.5	45	37.5	30
	Safe Working Load, Pounds								
1/4	300	295	290	280	260	240	210	180	150
3/8	700	695	675	645	605	555	495	425	350
1/2	1200	1190	1160	1110	1040	950	850	730	600
5/8	1900	1880	1835	1755	1645	1505	1345	1160	950
3/4	2700	2675	2610	2495	2340	2140	1910	1645	1350
7/8	3700	3665	3575	3420	3205	2935	2620	2255	1850
1	4800	4750	4640	4435	4160	3810	3395	2925	2400
1 1/4	7500	7425	7245	6930	6495	5950	5300	4570	3750
1 3/8	9100	9000	8790	8410	7880	7220	6435	5540	4550
1 1/2	10800	10690	10435	9980	9350	8565	7635	6580	5400
1 3/4	14700	14555	14200	13585	12730	11660	10395	8950	7350

Machinery

[1] The elastic limit has been assumed as 24,000 pounds per square inch and the maximum allowable fiber stress as 12,000 pounds per square inch.

Value of Stud Links

The introduction of a stud in a link has unquestionable value if the stresses are kept within the elastic limit. A stud link exhibits a somewhat more uniform distribution of the stresses throughout the metal than an open link. Besides, there is a reduction of the maximum tensile stress by about 20 to 25 per cent, and a decrease in the compression at the inner ends of the link of about 50 per cent, and its net strength at rupture is lower. This fact does not conflict with theory, for, after the elastic limit is passed, the sides of the open link straighten out, thus eliminating the bending stresses, whereas in the case of stud links, the studs prevent collapse of the sides, thus retaining the bending stresses and consequently inducing greater strain for the same load. Since a chain should not be stressed up to its elastic limit, these last observations are merely of academic interest in factories and work-shops. For proper working conditions, therefore, a stud-link chain is stronger than an open-link chain.

TABLE 2. FACTORS FOR DETERMINING HORIZONTAL COLLAPSING FORCE

Central Angle, Degrees								
0	15	30	45	60	70	90	105	120
Horizontal Angle, Degrees								
0	82.5	75	67.5	60	52.5	45	37.5	30
Factors								
0	0.06	0.13	0.21	0.29	0.38	0.50	0.65	0.86

Machinery

Annealing Chains

Recently, the value of annealing chains has been seriously questioned. As regards safety and length of life, it is quite generally conceded that the process can in no sense be considered as important, dependable, or effective as is proper caution in the imposition of only really safe loads; that is, such loads as do not induce a maximum fiber stress beyond the elastic limit of the material of which the chain is fabricated. As already stated, in good, safe practice, the imposed load should be well within that limit; this point cannot be too strongly emphasized and insisted upon. A general but somewhat indefinite idea seems to prevail in the industries that fatigue, or crystallization, will be produced in iron and steel after long service, and that annealing will in every case restore the structure to its original physical condition. That this does not follow and that in many cases the result of the treatment is quite disappointing is now generally admitted by those best able to speak with authority, through experience and technical training.

At a recent conference of the National Safety Council held in Chicago, it was clearly pointed out that annealing is a very delicate and technical process, and that it must not be expected to be successful unless carried out by experts with a full knowledge of such conditions as the chemical composition of the metal to be treated, the exact temperatures attained in the process, etc.; and that unless numerous precautions and extreme watchfulness are observed, the practice is likely to result in more harm than good. The annealing of chains before they are first used is good practice, as in that way any internal stresses that may have been set up in the process of manufacture are thereby relieved. Annealing a fatigued or crystallized chain may improve its ductility without restoring

its original physical properties. In every case, however, the annealing should be carefully performed by qualified men under proper conditions as to determination and government of the temperature, and with a full knowledge of the chemical composition of the material under treatment, it being, of course, further understood that proper apparatus is available for carrying out the necessary operations.

One of the service bulletins issued by the National Safety Council gives the following instructions: Each chain should be marked by stamping some identifying letter or number on the connecting ring. This mark should refer to a card record containing the following information: Description of material used in manufacture; dimensions of chain; class of work for which it is used; proof test; safe working load; date issued for service; date of repair and nature and extent of repair.

An inspection should be made at least once a week, and oftener if the chain is in constant use, by a competent and experienced man, to detect any appreciable reduction of section in the links due to wear or abrasion, any deformation of the links due to overloading, and visible flaws in the welds. Chains that have been overloaded to such a point as to cause fatigue can be detected, when struck a sharp blow with a hammer, by a characteristic ring. Further proof of such condition can be obtained by placing the link edgewise on an anvil and striking it several sharp blows with a sledge; if it is fatigued, the link will fracture sharply with a decided crystalline appearance. In case a chain is found to contain a link of such a nature, the entire chain should be discarded for all overhead lifting purposes where life might be endangered. The connecting ring must be designed to resist the same safe load as the chain. The following formula is recommended:

$$P = \frac{0.617Fd^2}{D}$$

in which P = safe load;
F = fiber stress of material used;
d = diameter of stock in ring;
D = main diameter of ring.

The hook must be properly designed by a competent engineer. Common practice seems to overlook the fact that it is a matter of strength in a curved beam rather than a straight beam, and therefore gives a load far too large for safety.

Most important of all, the chain must not be overloaded. In case it has been overloaded, annealing should not be used as a remedy, for annealing positively will not restore the original physical qualities of the material used in the chain. If chains, hooks, or rings have been overloaded, they should be scrapped.

* * *

JIG FOR DRILLING STEERING ARMS

For use in drilling the 1.250-inch hole in motor truck steering arms, the Windau Tool Co., 1565 E. 17th St., Cleveland, Ohio, recently made the jig shown in Fig 1. Owing to the means provided for securing work in this jig ready to be drilled, and for releasing the finished part after the operation has been performed, this is styled a "pump" jig. Bushing A is of the bell-mouthed type, and drops down over the top of the boss at the end of the steering arm. The threaded end of the work is supported by means of a slotted block B carried at the end of bracket C.

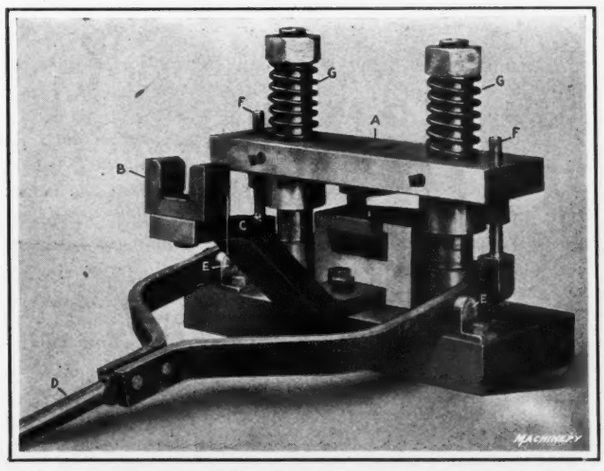

Fig. 1. "Pump" Jig for drilling 1.250-inch Hole in Steering Arms

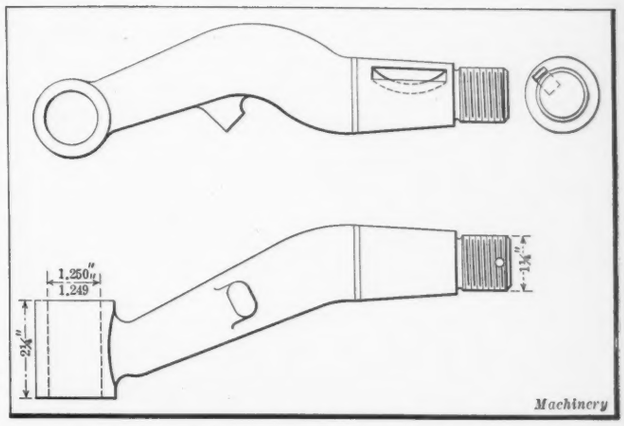

Fig. 2. Type of Steering Arm drilled in Jig shown in Fig. 1

When it is desired to set up a piece of work in the jig, "pump" handle D is pushed down; this handle swings on pivots E, with the result that rods F raise jig bushing A against the pressure applied by coil springs G. The piece of work is then slipped into place and handle D is released so that springs G apply sufficient pressure to enable bushing A to hold the work in the desired position to be drilled. This arrangement will be readily understood by comparing the jig with the work shown in Fig. 2.

After the drilling operation has been completed, it is a simple matter to release the work from the jig by pushing down the handle D and withdrawing the piece from under the bell-mouthed bushing. This drill jig was designed by the Columbia Axle Co., and made for use in that concern's shops by the Windau Tool Co. E. K. H.

* * *

HIGH-SPEED STEEL FOR MILLING CUTTERS, TAPS, AND REAMERS

While tungsten high-speed steel has been used for some years for probably nine-tenths of all turning, planing, and slotting tools, it has been employed for a much smaller percentage of milling cutters, taps, reamers, etc. This small use is partly due to the difficulty of hardening tools with fine edges, for to obtain the best cutting efficiency, tungsten high-speed steel requires hardening at from 1250 to 1350 degrees C. As the manufacture of munitions calls for the most efficient tools of all kinds, experiments were made by Darwin & Milner, of Sheffield, England, to find a steel that, without tungsten, would possess the hardness of the so-called high-speed steels. As a result, it was discovered that the addition of cobalt to chromium-carbon steel produces a most satisfactory tool with a hardening temperature of only 1200 degrees C.; in fact, if this is exceeded, the tools give poorer results. Hardening for practically all applications is said to be satisfactory when the tool is allowed to cool naturally in still air, free from drafts. This new alloy, known as "cobalt-crom," has been found especially suitable for milling cutters, twist drills, reamers, taps, and forming tools, and for machining gun-metal and yellow metals, as well as for high-endurance drawing and blanking dies, lathe centers, shear blades, airplane and automobile engine valves, and all gages and instruments that must resist abrasion. In one test, it was possible to cut for a half day with carbon-steel saws without regrinding; for two days with tungsten high-speed steel saws; and for four days with cobalt-crom saws. It is also claimed that, in the form of castings, the cutting efficiency of this steel is as good as that of tools made from forged or rolled high-speed steel bars.

* * *

An employe who was injured by a dog the engineer was permitted to keep around the plant was said, by the New York Supreme Court, to have been injured in the course of his employment and therefore entitled to compensation.

ELECTRIC STEEL MAKING[1]

IMPORTANCE AND GROWTH OF ELECTRIC STEEL INDUSTRY—COLD-MELT PROCESS AND STRUCTURE OF ELECTRIC STEEL

BY ARTHUR V. FARR[2]

THE cutting off of the steel supply from abroad through the war made it necessary for American manufacturers to make steel which had previously been imported, and the assistance rendered the steel manufacturers by the forging concerns during the first attempts at making these steels (many of them complicated alloys requiring special manufacturing methods) has proved invaluable. This cooperation has doubtless reacted favorably on the American forging industry, enabling it to serve most effectively our military requirements, as well as the automotive and allied industries. Any lowering of the quality or production of steel has also been prevented. According to the experience of a large forging company, it is now getting better steel than was obtained from Germany—better in uniformity and better in physical results after heat-treatment. This company does not intend again to use foreign steels. This experience has undoubtedly been typical of a large number of forging companies during the last three years. Certain it is that the full exchange of ideas, criticisms, and suggestions between forger and steel maker has enabled the forger to get a domestic source of supply and to meet the exacting requirements of the present day on a better basis than ever before.

Growth of Electric Steel Industry

America has been known as a producer of steel in quantity, and it has been but recently that the quality element has been emphasized. The continued production of quality steels is making America's reputation symbolic of both quantity and quality. A newcomer in the industry and a factor in the production of higher grade steels is the electric furnace method of production. The United States had only 10 electric furnaces in 1910, but the growth in the number of installations has been rapid, and on May 1, 1918, 239 furnaces were either in operation or in the course of construction in this country. The United States has not only maintained its commanding position as a producer of electric steel, but the record of 1917 emphasizes this leadership. The United States and Canada are producing at the present time probably a little less than half of the world's production. The industry has grown so rapidly and has become so important a factor in the forging industry that it might be advisable to review briefly the method of making electric steel and to call attention to some of the salient qualities of the product of the electric furnace as applied to the forging industry.

Cold-melt Method and Refining of Molten Charges

Electric steel is made either by melting a cold charge and refining it in the electric furnace (known as "cold-melt electric steel"), or by refining in the electric furnace the molten charge from the open-hearth or Bessemer or a combination of both. The latter method is applicable especially to furnaces of capacity of ten tons and over, the cold-melt method not having proved successful to date in the large units.

For smaller units under ten tons' capacity, the cold-melt method predominates. This is due largely to the simplification of equipment and the assurance of electric steel quality. Although there is economy in duplex or triplex methods of making electric steel, certain it is that plants equipped exclusively with electric furnaces cannot be accused of merely "washing" the open-hearth steel in the electric furnace. It cannot be gainsaid that satisfactory steel can be produced by the open-hearth electric furnace method, provided, of course, that sufficient time is allowed for refining in the electric furnace. Perhaps this point is best illustrated by the present-day attitude taken by some steel purchasers. A request for quotations was sent by a large purchaser of chrome steel and contained the following: "If you are not in position to quote on either electric or crucible steel, we prefer that you disregard the inquiry, as we do not care to consider open-hearth steel or open-hearth with electric furnace refinement." While this attitude cannot be considered as typical, it shows the discrimination that particular purchasers of steel have found it necessary to exercise in safeguarding the quality of their product.

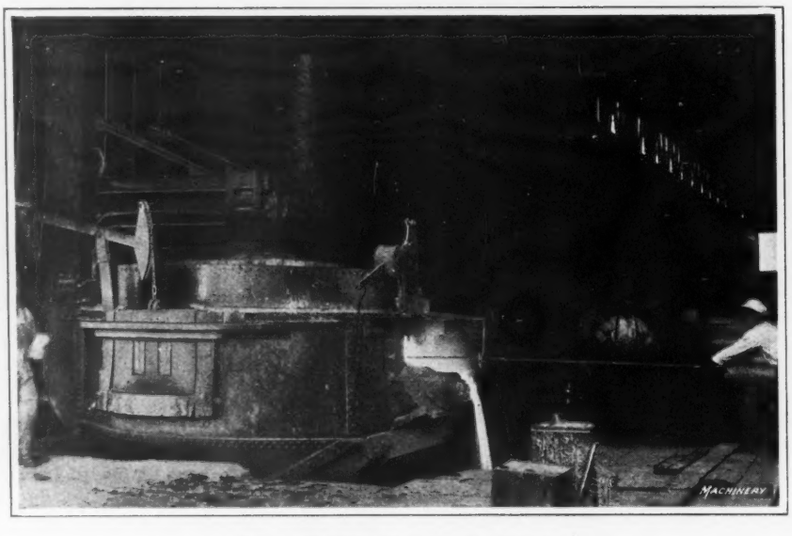

Fig. 1. Slagging off an Electric Furnace

The electric furnace consists essentially of a steel tank lined with refractory materials and fitted with working doors, spout, and tilting arrangements for pouring and slagging off. Carbon or graphite electrodes of suitable section are inserted through the roof or sides and can be regulated. A high-tension electrical supply is brought into a transformer house adjoining the furnace and transformed down to about 100 volts for use at the electrodes. The heat generated by the electric arcs makes possible any desired temperature up to the fusion point of the best refractory materials. The temperature is under the operator's control, and is changed as the refinement of the steel progresses.

Making Cold-melt Electric Steel

The method of manufacture of cold-melt electric steel in a six-ton Héroult electric furnace will be described briefly, as being representative of the majority of installations in this country. The process of manufacture may be divided into two periods, namely, (1) melting and oxidizing, and (2) recarburizing and reducing. It appears paradoxical to remove carbon during one period and to add it at another, but this is necessary in order to oxidize the phosphorus. Furnaces for reducing phosphorus are lined with basic material, such as magnesite or dolomite. Limestone is charged into the furnace with the scrap. The rust on the scrap furnishes the oxygen, and sometimes ore or roll scale is charged to augment this supply. The slag formed oxidizes the phosphorus, which then combines with the lime, forming calcium phosphate. Carbon, silicon, manganese, and sulphur are also oxidized to a greater or less extent by this slag.

As an illustration of the furnace reactions that take place, the following schedule is given, showing the various stages

[1] For information on this subject previously published in MACHINERY, see "Electric Steel," in the August number.

[2] Abstract of a paper presented by Arthur V. Farr, sales manager of the Hess Steel Corporation, Baltimore, Md., at the fifth annual meeting of the American Drop Forge Association, Buffalo, June 21, 1918.

in the making of a heat of electric steel. The steel to be made was a high-carbon chrome steel used for balls for ball bearings.

11:50 A. M. Material charged:

Boiler plate	5980 pounds
Stampings	5991 pounds
Limestone	700 pounds

12:20 P. M. Completed charging (current switched on).

3:20 P. M. Charge melted down.

Preliminary analysis under black slag: Carbon, 0.06 per cent; silicon, 0.014 per cent; sulphur, 0.032 per cent; phosphorus, 0.009 per cent; manganese, 0.08 per cent.

3:40 P. M. The oxidizing (black) slag is now poured and skimmed off as clean as possible to prevent rephosphorizing and to permit adding carburizing materials. For this purpose carbon is added in the form of powdered coke, ground electrodes, or other forms of pure carbon. The slagging off is illustrated in Fig. 1.

The deoxidizing slag is now formed by additions of lime, coke, and fluor-spar (and for some analyses ferro-silicon). The slag changes from black to white as the metallic oxides are reduced by these deoxidizing additions and the reduced metals return to the bath. A good finishing slag is creamy white, porous, and viscous. After the slag becomes white, some time is necessary for the absorption of the sulphur in the bath by the slag to take place.

Fig. 2. Electric Steel being poured into Ingots

The action of desulphurization in the electric furnace is as follows: After the bath has been oxidized as previously described, the slag acts on the metallic sulphides, eliminating them by forming calcium sulphide, which is taken up by the slag. The white slag disintegrates to a powder when exposed to the atmosphere and has a pronounced odor of acetylene when wet. Further additions of recarburizing material are added as needed to meet the analysis. The further reactions are shown by the following:

3:40 P. M. Recarburizing material added:

Ground electrodes	130 pounds
Ferro-manganese	25 pounds

Analysis: Carbon, 0.75 per cent; silicon, 0.011 per cent; sulphur, 0.030 per cent; phosphorus, 0.008 per cent; manganese, 0.26 per cent.

To form white slag there was added:

Lime	225 pounds
Powdered coke	75 pounds
Fluor-spar	55 pounds

4:50 P. M. Analysis: Carbon, 0.75 per cent; silicon, 0.014 per cent; sulphur, 0.012 per cent; phosphorus, 0.008 per cent; manganese, 0.28 per cent. (Note the reduction of the sulphur content.)

During the white slag period, the following alloying additions were made:

Pig iron	500 pounds
Ferro-silicon	80 pounds
Ferro-manganese	9 pounds
Six per cent carbon ferro-chrome	146 pounds

The furnace is now rotated forward to an inclined position and the charge poured into the ladle, from which, in turn, it is poured into molds.

5:40 P. M. Heat poured.

Analysis: Carbon, 0.97 per cent; silicon, 0.25 per cent; sulphur, 0.014 per cent; phosphorus, 0.013 per cent; manganese, 0.33 per cent; chromium, 0.70 per cent.

Ingot weight poured	94.0 per cent
Scull	2.7 per cent
Loss	3.3 per cent

Total current consumption for the heat, 4700 kilowatt-hours, or 710 kilowatt-hours per ton.

Electric steel, because of its density, should be cast in inverted molds with refractory hot tops, to prevent any possibility of pipage in the body of the ingot. In the further working of the ingot, whether in the rolling mill or forge, special precautions are taken in the heating, in the reduction of the metal, and in the cooling. Fig. 2 illustrates how the ingots are poured.

Structure of Electric Steel

There is a growing tendency for forging concerns to have well fitted up laboratories for the examination of the structure of the steel that they are using. This is distinctly a forward step and points the way to accurate heat-treatments and more satisfactory results. The demands of high-power guns, airplane engines with weight well below three pounds per horsepower, and safe, light-weight automobiles all necessitate the use of the proper kind and weight of steel. These results can only be obtained by the use of properly selected grades.

Some typical photomicrographs of cold-melt electric steel are shown in Figs. 3 to 5 and 7 to 9, inclusive. The results indicated are average and such as can be obtained or improved upon in practical experience. Figs. 3 and 4 show carbon tool steel of the following analysis: Carbon, 0.77 per cent; silicon, 0.189 per cent; sulphur, 0.019 per cent; phosphorus, 0.018 per cent; manganese, 0.37 per cent. Fig. 3 is a view of the steel in its annealed state and shows the laminated pearlite. Fig. 4 shows the structure of the steel after hardening. The steel is quenched in oil from a temperature of 1425 degrees F. Martensite is visible at a higher magnification.

Figs. 5 and 7 show chrome-vanadium steel of the following analysis: Carbon, 0.37 per cent; silicon, 0.16 per cent; sulphur, 0.021 per cent; phosphorus, 0.02 per cent; manganese, 0.61 per cent; chromium, 0.89 per cent; vanadium, 0.16 per cent. The view of the annealed steel, Fig. 5, shows the small grain size and the uniform distribution of the ferrite and pearlite. The structure of the hardened steel, Fig. 7, is martensitic.

Figs. 8 and 9 show chrome steel for ball bearing races. This steel contains 1.07 per cent carbon, 0.221 per cent silicon, 0.018 per cent sulphur, 0.017 per cent phosphorus, 0.41 per cent manganese, 1.30 per cent chromium. The view, Fig. 8, of the annealed steel shows the moderate size of grain and the uniform distribution of the ferrite and pearlite. The hardened steel, Fig. 9, is of martensitic structure and very uniform.

The toughness of chrome-vanadium cold-melt electric steel is indicated by the distorted pieces shown in Fig. 6. The rod

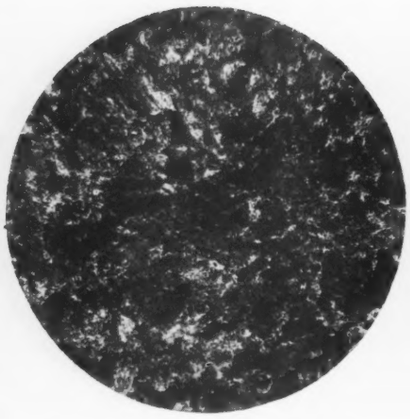

Fig. 3. Annealed Carbon Tool Steel

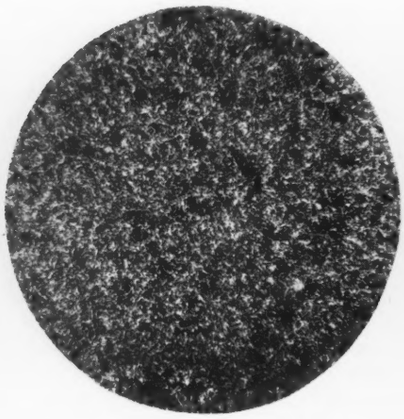

Fig. 4. Hardened Carbon Tool Steel

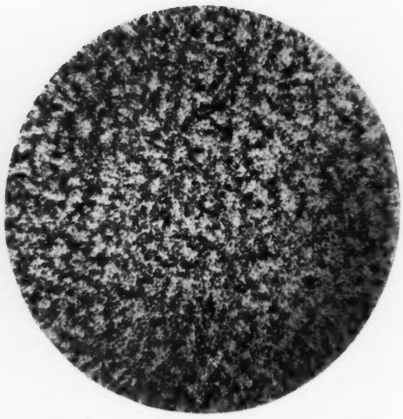

Fig. 5. Annealed Chrome-vanadium Steel

at the left, which is 1⅛ inch in diameter, has been bent while cold without cracking, and the airplane engine connecting-rod at the right has been twisted through an angle of over 180 degrees without any sign of failure.

No attempt has been made to compare at length the relative merits of open-hearth and electric steel. The writer does not believe that such a comparison is necessary, because results in service, day in and day out, have thoroughly established the superiority of electric steel. Individual laboratory tests do not always square with results in the field—but it is the latter that are wanted. One forger expressed his experience tersely as follows: "We can get physical properties much easier with electric steel." Ten years of experience in this country and in Europe indicate that electric steel in its natural qualities is equal to crucible steel and superior to the steel ordinarily made in the open-hearth furnace. The rare purity of the heat derived from the electric arc, combined with definite control of the slag in a neutral atmosphere, explain, in part, the superiority of electric steel. Commenting on this recently, Dr. H. M. Howe stated that in the open-hearth process you have such atmosphere and slag as you can get, and in the electric you have such atmosphere and slag conditions as you desire.

The ultimate consumer, in a large measure, is the court of last resort, determining what steels shall be used in the manufacture of his product. It is the ultimate consumer who realizes that the best materials obtainable are none too good, and the drop-forger, knowing this and that the difference in cost of steels is small compared with the labor, forging equipment, and after expense put upon forgings, finds that it is economy to use high-grade electric steel.

* * *

The Ordnance Department has revised the specifications formerly issued for steel castings in a manner that will materially aid in the rapidity of manufacture of war materials and increase the output of open-hearth and converter foundries. The specifications cover three classes of steel castings known as Nos. 1, 2, and 3. Steel casttings No. 1 must have an elastic limit of 27,000 pounds per square inch; a tensile strength of 60,000 pounds per square inch; an elongation of 22 per cent; and a contraction of area of 30 per cent. Steel castings No. 2 must have an elastic limit of 32,500 pounds per square inch; a tensile strength of 70,000 pounds per square inch; an elongation of 18 per cent; and a contraction of area of 25 per cent. Steel castings No. 3 must have an elastic limit of 42,000 pounds per square inch; a tensile strength of 80,000 pounds per square inch; an elongation of 15 per cent; and a contraction of area of 20 per cent.

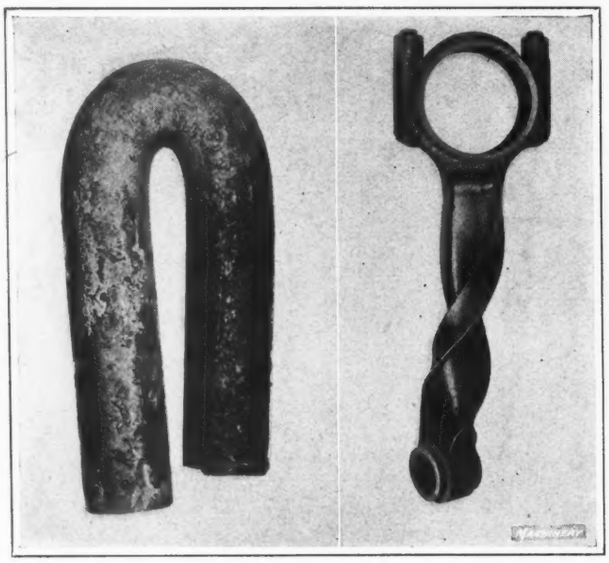

Fig. 6. Illustrating what Chrome-vanadium Cold-melt Electric Steel will withstand without cracking

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The price of platinum has increased from $14.40 an ounce, in 1898, to $105 in the present year.

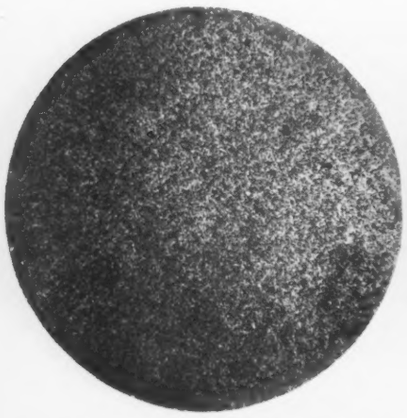


Fig. 7. Hardened Chrome-vanadium Steel showing Martensitic Structure

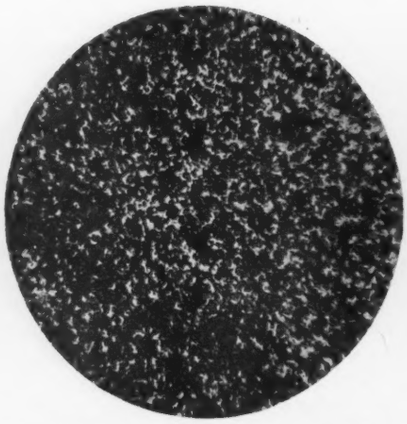


Fig. 8. Annealed Chrome Steel for Ball Bearing Races, Brinell Test 174

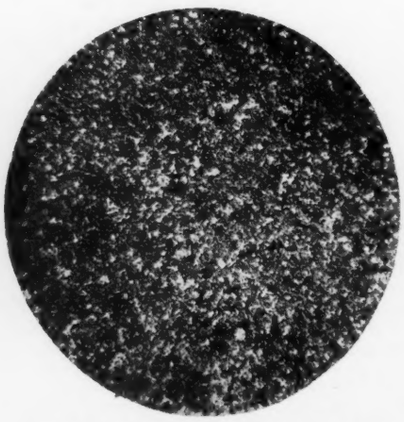


Fig. 9. Hardened Chrome Steel for Ball Bearing Races, Brinell Test 680

MANAGEMENT OF A CARBURIZING PLANT

BY C. B. LANGSTROTH[1]

In the December number of MACHINERY, on page 329, was published a description of a well-arranged carburizing plant. The system of operating this plant is equally interesting, especially as a plant of this kind often is run on a hit-or-miss principle. In considering how this plant could be run to the best advantage, the functional system was chosen. All overlapping of duties, authority, and so forth, was done away with by using only the primary requisites of manufacturing,

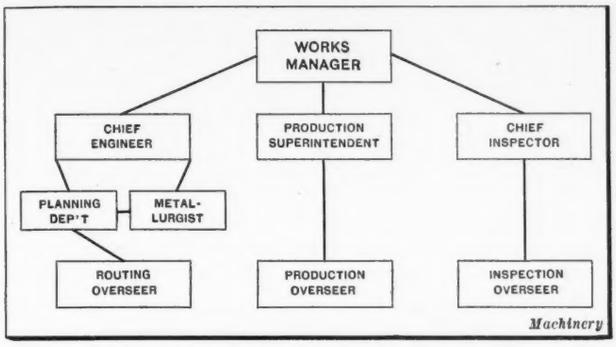


Fig. 1. Organization of Carburizing Plant

namely, conceiving, making, and examining; or, in other words, having only three divisions, planning, production, and inspection. To provide the departments thus formed with a court of appeal, they were grouped under the works manager. In Fig. 1 is shown graphically the system of organization in the plant under consideration.

Probably no work is as hard to systematize as carburizing, owing to the fact that in most cases the foremen have grown up with the work, and hence resent having outsiders try to standardize their practice. To establish the department on a functional basis, it was necessary to obtain records of the methods of packing, the compound, time, and so forth. These records were placed on cards 5 by 8 inches, arranged as shown in Fig. 2, and then standardized. To do this, it was necessary first of all to find how much work could be packed in a pot, so one was packed and the quantity thus determined. As the pots and furnaces were already designed to suit the work, no change had to be made in them; but if this had not been the case, that would have been the next step to take.

Next the compound was considered. As most of the mixtures sold by reliable dealers are about the same, the principal requirements considered were: lightness, as the lighter is the cheaper when bought by weight; porosity, to allow quick

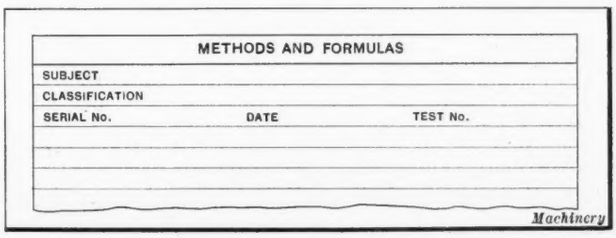


Fig. 2. Records of Packing, Compound, Time, etc.

heating; mechanical strength; and good lasting qualities. A carburizing depth of 0.025 to 0.035 inch was decided as sufficient for a light case, and from 0.045 to 0.055 inch for heavy work.

Frequently the temperatures used were found to be wrong; hence these had to be considered more or less from the theoretical standpoint and checked by practice. The carburizing temperature of the furnace for each sized pot was checked by inserting the fire end of a pyrometer in a hole in the pot packed as usual and then finding the furnace temperature necessary to bring this end up to carburizing heat.

To determine the time required for the operation, the furnace factor for each pot had to be obtained. By the "furnace factor" is meant the time required to start carburizing for any given pot at a given temperature in a given class of furnace, as determined above. This time will change with the class of work and other variables, but after making a number of tests, an average result may be obtained that can be used as a standard. For any given depth of case, it is then necessary only to add an additional time to this furnace factor. Whenever it is necessary to reheat the work in order to improve the case or core, it has been found best to have reheating scheduled, for this keeps the system working smoothly. Lastly, the quenching medium must be standardized. In doing this, where oil is used, the oil must be kept at a constant specific gravity and at a temperature of from 70 to 90 degrees F.

As soon as this information was standardized and the record cards rewritten, the planning department began to use the cards when scheduling the work. All work is delivered in lots to the receiving room, where it is weighed and signed for; these weights are then used in figuring pay on the previous piece-rate job. It has been found necessary to split up these lots into smaller batches for the packing room, the size of which was determined by the amount required for a heat, which had been previously ascertained and recorded. With each batch is sent a card that designates the pots, compound, heats, etc., that are to be used. These cards, one of which is shown in Fig. 3, are enclosed in a small flat cloth case with a celluloid front, which keeps them clean. They are filled in by the heater when the heat is charged into the furnace, also noting any variation in the time from that scheduled, and the inspector notes the time at which he gives permission for the heat to be pulled, when this does not check with the given

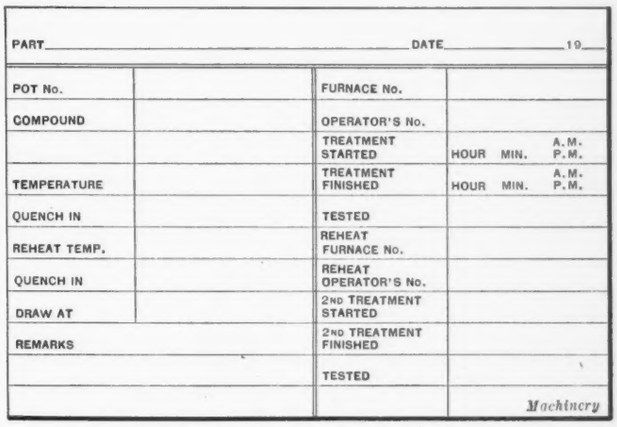


Fig 3. Record Cards that accompany Work

time of pulling. In the spaces for test, the inspector notes whether the work is properly treated or not. The finished work, on reaching the final inspection, is held until all the batches have been completed and the entire lot is sent out together. In case any work is spoiled, it is rerouted by the planning department after a consultation with the metallurgist in regard to its proper treatment.

* * *

LIQUID OXYGEN AS AN EXPLOSIVE

The scarcity of substances commonly used in the manufacture of explosives has caused a revival of the use of liquid oxygen in connection with carbonaceous substances to produce an adequate substitute for dynamite. Various carbonaceous materials are placed in a cheesecloth container, together with a detonator. The cartridge is then dipped into liquid oxygen, completely and instantaneously oxidizing the carbon and causing detonation. While the best grade of oxygen at present contains but 55 per cent of that element, a strength equal to 40 per cent dynamite is thus obtained. The efficiency of this explosive, which is said to be used extensively in Germany for blasting coal in the mines, is claimed to be equivalent to dynamite at 12 cents per pound.

* * *

For every Ford car manufactured, waste material valued at four dollars is produced. In addition to the cast-iron borings and sheet-steel clippings used in the foundries, the scrap material produced last year was sold for $3,000,000.

[1] Metallurgist, Rahway, N. J.

AUTOMATIC CABLE WINDING MECHANISM

ARRANGEMENT FOR WINDING CABLE USED IN MAKING LEAD BALLS FOR SHRAPNEL SHELLS

BY DONALD A. BAKER[1]

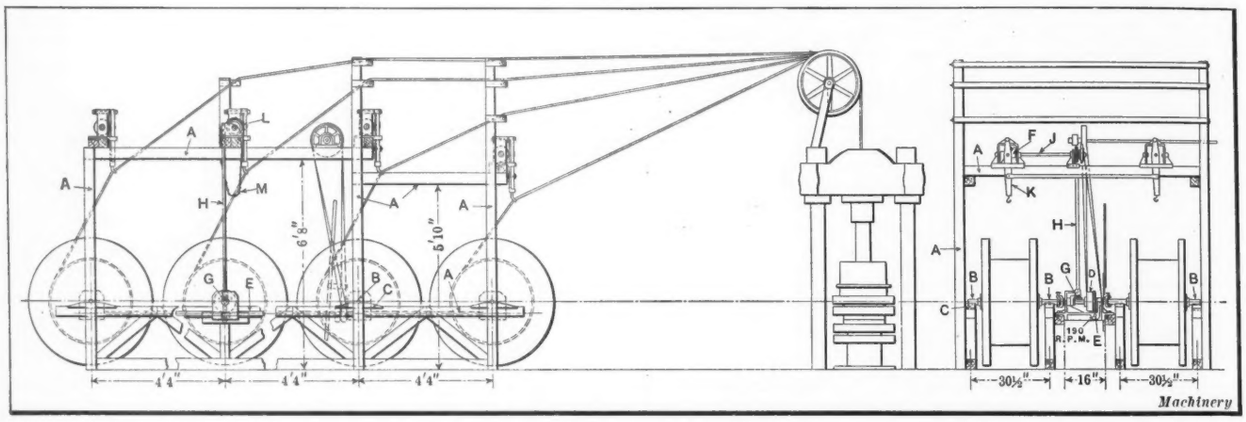


Fig. 1. General Assembly of Winding Mechanism

IN the manufacture of shrapnel shells, millions of lead balls are used, each shrapnel containing several hundred. These balls are about one-half inch in diameter, and several different methods are used in making them. Some firms are casting them in molds which cast several hundred at a time, while others are making them from cable, drawn to the right diameter and then run through punch press dies which swage them out to the shape desired. It is the latter method which will be described in this article.

The lead is purchased in pigs of the usual shape. These pigs are charged into big melting pots and, after being melted, are run into iron molds and recast into ingots four or five inches in diameter and about eighteen inches long. These molds are water-jacketed and cool the lead rapidly. As soon as they are cool they are ejected from the molds and taken to a furnace next to an extrusion press, and as they roll through it they are warmed up but not so much that a man with gloves on cannot handle them. From the furnace they are placed in the lower die of the hydraulic extrusion press. Then as the operator pumps up the lower ram of the press the ingot is forced against the four dies which are held in the upper member of the press; these dies are simple button dies, with holes through them of the same size as the cable which is to be made. The continued upward movement of the press ram forces the lead to flow through these holes and so forms the cable. It may be interesting to note that the great pressure used and the friction produced generate sufficient heat to practically melt and fuse the metal of one ingot into the next one, so that no matter how many ingots are run through the press there is no break in the cable. In some cases where the presses are run too fast or where the ingots are too hot before being put into the press, the metal seems to be in a melted condition when it flows through the dies. The effect of this can be seen on the finished cable in the form of raised blisters or lumps.

After the metal is extruded from the dies, it is carried up through the press and over a series of grooved pulleys at the top of the press. This is plainly shown by the illustration Fig. 1. In ordinary practice it is then carried over a set of rollers and down to the reels, on which it is wound by hand. This necessitates employing one man to a reel, and is both a slow and tedious job. To overcome this and at the same time to obtain a more uniform winding than was possible by hand, the mechanism about to be described was designed, which put the operation of winding in the hands of the press operators, only employing other labor to remove and replace reels and to see that the cable was attached to the reels properly at the beginning. Two men were sufficient for this work, where sixteen men were formerly required, as the installation consisted of four extrusion presses, and the reel stands held thirty-two reels, sixteen reels being wound while the other sixteen were being changed.

The assembly views will give a good general idea of the layout of the winding frames and their relation to the extrusion presses. The framework *A* is made of wood. The frame which carries the cast-iron bearings *C* on which the reels rest is made just high enough so that when the reels are rolled along on the floor the piece of pipe *B* which passes through the center of the reels and is used to carry them will just clear the floor. It will be noted that the bearings are tapered down to meet the woodwork, thus making it easy to roll the reel up and into the bearing, where it will remain of its own weight.

In constructing an automatic winding device, the following factors had to be taken into consideration: First, it was found by experiment that a pull exceeding fifty or sixty pounds would stretch the cable at the point where it first left the dies in a heated state, and this would reduce it in diameter. Second, on account of slight variations in the sizes of the dies or of their smoothness or other causes, the flow of the cable was not uniform, and in consequence the reels had to revolve at different speeds in order to keep the slack out of the cables.

These conditions were met in the following manner: The drive for each set of rolls was through a friction device shown at *D*, Fig. 1, which was set to give the maximum tension on the cable. Each set of eight rolls was driven by four of these frictions, and the frictions, in turn, were driven from one main drive shaft *E*. The construction of the friction drive is shown in Fig. 2. The main drive shaft *E* is driven at a constant speed, which is just a little faster than the greatest speed at which it is required to drive the reels. This arrangement, then, took care of both the tension on the cable and any variation in the feed of the cable to the reels.

The mechanism for controlling the laying of the cable uniformly on the reels was a simple matter, as it was patterned after the bobbin winders which are in common use on some types of

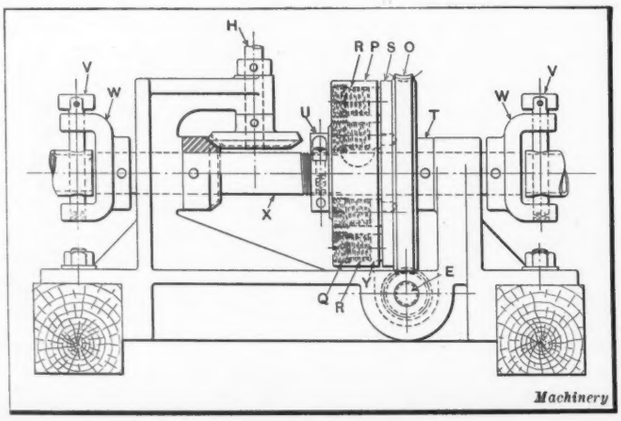


Fig. 2. Assembly of Friction Drive

[1]Address: Care of Service Engineering Co., 25 Church St., New York City.

sewing machines, the only essential difference being in the employment of a drum cam *F*, Fig. 1, in place of the usual heart-shaped cam. The drive for this is taken from the shaft *E*, which is used to drive the reels, a set of bevel gears at *G* being placed beyond the friction device driving a vertical shaft *H*, as shown. At the top of shaft *H* is a worm and worm-gear, as shown in Fig. 3 at *I*, which drives the camshaft *J*. The worm and worm-gear were used on account of the reduction which was required, this reduction being 64 to 1, as thirty-two strands of cable could be laid on the width of the drum wound in one direction, and thirty-two wound in the other direction, making the winding two strands deep.

It was necessary on starting the cable to have the arm which controlled the laying of the cable in the proper position at the side of the drum to which the cable was attached, and as it was known that these arms might be at any point in the length of their stroke at the time it was necessary to change drums, some means had to be provided for adjusting them. Assuming that it was impossible to throw the lever *K*, Fig. 1, either one way or the other by hand, a sprocket wheel *L* and chain *M* were incorporated, the sprocket wheel being permanently connected to the camshaft *J* and being driven by the worm-wheel *N*, Fig. 3, which is a free fit on the camshaft through a ratchet which drives the sprocket and camshaft in one direction only. Adjustment of the cam and of the reeling arm was made by pulling on chain *M*, which passed over the sprocket, the sprocket being turned in a direction that would release the ratchet. This chain was later discarded, as it was found possible, by reaching up and taking hold of the reeling arm, to shift it to the desired position by first moving it in a direction which would release the ratchet.

The ratchet mechanism, as well as the worm and worm-gear for driving the camshaft, are shown in Fig. 3 and are clear enough to need no further description. The assembly drawing Fig. 2 shows the reel-driving friction mechanism and the method of connecting to the reel shafts, these being nothing more than tubing. The belt drive shown in Fig. 1, which has a tight and loose pulley to provide for starting and stopping the machine, was replaced by a motor drive, which proved more satisfactory. With the motor drive arrangement the press operator could start or stop the machine at will by means of a conveniently located switch. Fig. 2 shows a housing of cast iron, which is bolted over the wooden framework of the reel frame. The drive shaft *H* has its bearings in this housing. This housing also encloses the main drive worm on shaft *E*, which drives the worm-gear *O*. The latter is a running fit on the reel drive shaft *X*. Carried on the same shaft is the drum *P*, which has a number of holes in it, one end of these holes being tapped to receive short screws *Q*, which are of large diameter, while into the other side are placed heavy coil springs *R*, and on top of the springs, disks of fiber, rawhide, or other material, as shown at *Y*. At *T* is a hardened and ground collar, which is pinned to the shaft, while at *U* is a split nut, held together with screws as shown; these parts, with the plate *S*, which is screwed fast to the worm-gear and is polished on the side next to the drum, constitute the friction. The springs in the drum are first adjusted to hold each of the friction disks at a uniform tension, and the split nut provides for making any further adjustment or taking up wear. As the drum *P* is keyed to the drum-driving shaft, it is driven by the worm-gear when sufficient friction is set up between the small fiber disks contained in the drum and the larger disk which is fastened to the worm-gear. The two bevel gears shown are used, of course, to drive the cable-laying cam mechanism overhead through the vertical shaft *H*. The method of attaching the reel shaft to the driving mechanism is shown at *V* and *W*, and is clear enough to need no description.

With a mechanism of this kind, the control of the reeling is practically in the hands of the press operator, and the breakage of cable while in the process of winding, which was of frequent occurrence when being hand wound on account of the operators taking up the slack with a jerk, is practically eliminated. But the greatest saving, of course, is in the number of operators required for each press unit.

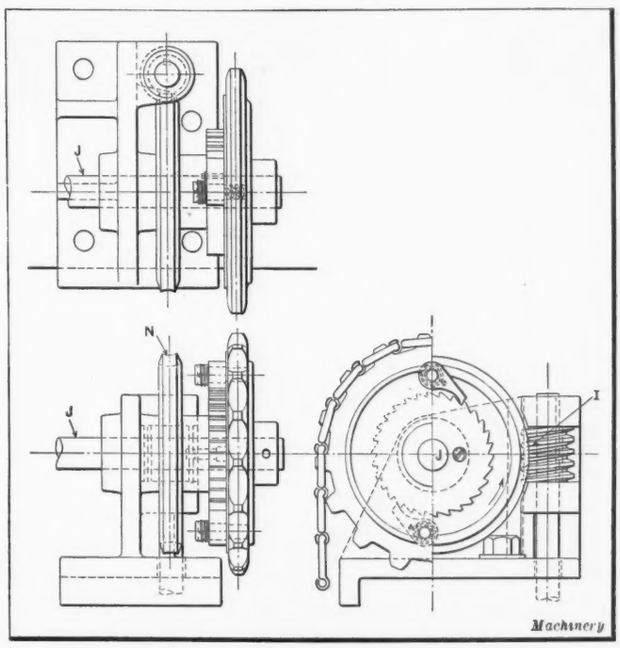


Fig. 3. Assembly of Driving Mechanism for Winding Cam

* * *

STRENGTH OF WELD IN WROUGHT-IRON PIPE

Welded wrought iron or steel is always subjected to a hydrostatic test before it leaves the mill. For most sizes of standard weight pipe a pressure of 750 to 1000 pounds per square inch is applied; but as the hydrostatic test is an evenly applied bursting load of short duration, it does not insure against the splitting of the pipe at the weld under torsional, tearing, or compression stresses encountered in the course of cutting, threading, bending, and installing. As a result, the strength or dependability of the weld is sometimes open to question, and new pipe may show a tendency to split under stresses apparently much below the hydrostatic test pressure. When the pipe is well made from a good grade of material, the percentage of such failures should be negligible, although they may not be entirely avoidable. Lap-welded pipe should be especially reliable.

A series of flattening tests on pipe that had been subjected to mill tests has been made by Edward A. Klages, of the University of Pittsburg. Out of 160 pieces of pipe of various sizes, both butt-welded and lap-welded, placed at varying angles to the vertically applied pressure, only 12½ per cent began to fail at the weld. The results of the tests led to the conclusion that the weld in genuine wrought-iron pipe is at least as strong as the body metal for a like application of stress. This was shown also by the fact that the position of the weld with respect to the applied load in flattening tests had no influence upon the location of the place of initial failure.

* * *

SUCCESSFUL TRAINING OF UNSKILLED MEN FOR MECHANICAL WORK

The following specific instances of manufacturers who have been successful in training their own help for urgent war work will prove of interest. The Curtis Aeroplane & Motors Corporation in seven weeks, by means of a training room, instructed hundreds of skilled workers so that they became superior to the regular skilled help. It was also found that the labor turnover, running into thousands annually, became an unimportant factor. Women workers in the training room, when properly taught, are able to splice cables in forty-eight minutes—work that formerly required one hour when done by the regular presumably skilled force. The Lincoln Motor Co. needed three hundred workers on airplane work and, unable to secure men, put in a training room for women and has found them, when properly trained, suitable for many classes of difficult machine work.

DIES FOR TAPE-MEASURE WINDER

SET OF DIES FOR PERFORMING SEQUENCE OF OPERATIONS UNDER POWER PRESS

IN the manufacture of a great variety of metal products, examples are to be found where important savings in the cost of production have been effected through the development of suitable dies for producing parts under the power press, instead of making them by some combination of machining methods. For performing those manufacturing operations on which it can be employed, the great advantage of the power press is the rapidity with which it turns out the work. A good example of the savings which are made possible through the application of properly designed punches and dies is seen in the case of a winder for a tape measure, which is shown at *A* in Fig. 1. The shell for this winder was formerly drawn up under a power press, but after this had been done the boss *a* for the bearing, stem *b* to which the end of the tape measure is fastened, and lugs to secure the pivoted crank *c*, were produced independently and soldered onto the shell. By this method, the cost was much greater than it would have been if the complete part could have been produced under the power press.

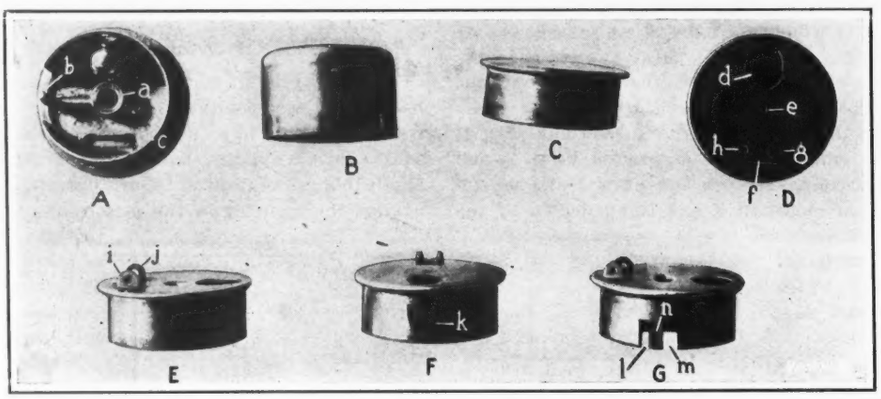


Fig. 1. Old Style of Tape-measure Winding Drum is shown at A; B, C, D, E, F, and G show Successive Steps in making Improved Type of Drum in Power Press

The problem of developing a set of dies for producing this part was submitted to the Nelson Tool Co., Inc., 781-783 E. 142nd St., New York City, with the result that provision was made for producing the complete winder—except the crank—under the power press, by a sequence of six operations. The first step is to draw up a cup *B* from sheet brass, which is done in a simple drawing die. After this operation has been completed, the next step is to "head up" the work, or, in other words, produce a flange around the top of the cup in order to bring the piece to the condition shown at *C*. In this connection attention is called to the fact that the upper surface of this flange is beveled off so that the surface will be smooth and without a sharp edge. The die used for this operation is shown in Fig. 2, and this illustration clearly shows the way in which the heading operation is performed. At each side of this die there are shown shells *B* and *C*, which correspond to the shells marked with the same letters in Fig. 1; and these shells indicate the condition of the work before and after it has passed through the die shown in Fig. 2. A better idea of the way in which this operation is performed will be obtained from Fig. 3, which shows a cross-sectional view of the die. It will be seen that shell *B* is dropped over inner section *D* of the die, and that outer die section *E* is counterbored at *F* to receive the lower part of shell *B* when stripper *G* is pushed down into a socket at the top of inner die section *D*. This inner die section *D* is then caused to slide down through the outer section *E* of the die as a result of pressure applied by the punch *H*, Fig. 2.

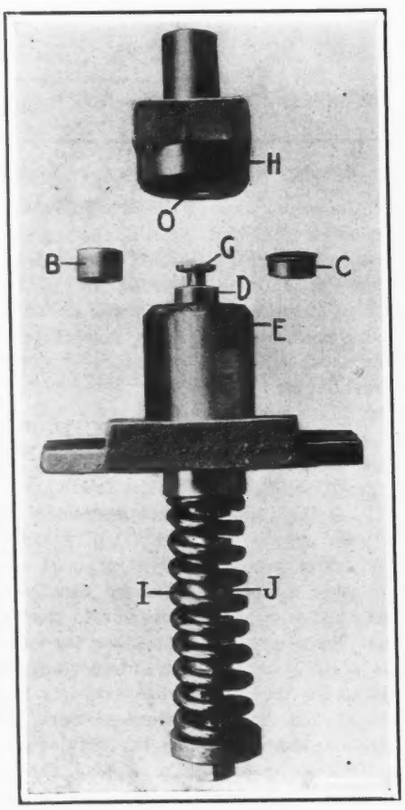


Fig. 2. Punch and Die used for forming Head or Flange on Shell

Below the die, it will be seen that there are two compression springs *I* and *J*, which are provided for pushing up the inner die section *D* and stripper *G*, respectively, while the punch is making its upward stroke. Three pins *K*, Fig. 3, transmit the pressure of spring *I* to inner die section *D*, and three pins *L* transmit pressure from spring *J* to stripper *G*. It will be apparent that spring *I* applies its pressure against collar *M*, which engages the lower ends of pins *K*, while spring *J* applies its pressure to collar *N*, which is a sliding fit inside of collar *M* and engages the lower ends of pins *L*. By making collar *N* somewhat longer than collar *M*, outer spring *I* fits over the end of collar *N*, which serves as a pilot to keep this spring in the desired position. It will, of course, be apparent that in operation inner die section *D* is pushed down until shell *B* reaches the bottom of counterbore *F* in outer die section *E*. During this time, pressure applied by spring *I* prevents shell *B* from slipping. When the edge of the shell has reached the bottom of counterbore *F* in the die, further downward travel of the punch results in pressing stripper *G* down into the pocket at the top of die section *D*, but as the work can no longer continue its downward movement, because it has reached the bottom of the counterbore in the outer die section, this downward movement of the stripper results in expanding the top of shell *B* to produce the desired flange or head on the work. It will be seen in Fig. 2 that a pocket *O* is provided in punch *H*, in which the top surface of the flange on the work is formed to give it the desired bevel; to which reference has been made.

Referring again to Fig. 1, it will be seen that the next step in the sequence of operations is to take shell *C* as it comes from the die shown in Figs. 2 and 3, and perform an operation to bring the work to the condition shown at *D*. This consists of stamping hole *d*, piercing hole *e*, punching hole *f*, and piercing holes *g* and *h*. The compound die used for this operation is shown in Fig. 4, and in this illustration different members of the die for piercing and punching the various holes in the work are lettered to correspond with the lettering on part *D* in Fig. 1. The work is shown at *C* and *D* in Fig. 4 before and after performing the operation in this die. It will be apparent that this is the usual compound die construction, with pilots *A* and *B* provided on the upper die section to maintain it in accurate alignment with the lower member of the die. The work is dropped into the pocket in the lower die member, and when the ram of the press descends, holder *E* that carries punches *d*, *e*, *f*, *g*, and *h* in the upper die slides back against spring pressure, allowing these punches to perform the desired piercing and punching operations on the work.

The purpose of the preceding operation will be better understood after describing the work done by the next die, shown in Fig. 5, which is used in the production of this piece. Conforming with the procedure followed in describing the previous tools, the work is shown at *D* and *E* before and after the performance of the operation by the tool shown in this illustration, and the reference letters correspond with the letters on the work shown in Fig. 1. It will be seen that the operation performed by this die consists of turning up two small lugs *i* and *j*, and drawing down the metal around the small central hole in the work to form a cylindrical shell or bushing. To maintain accurate alignment, the upper die member is piloted into the lower section of the die; and in performing the operation, shell *D* is dropped over die section *A*, on which it is located in the desired position by means of pilot *B*, which enters hole *d* in the work. When the upper die section descends, pressure applied to holder *A* results in depressing the holder so that punch *C* rises sufficiently to turn up lugs *i* and *j* on work *E*. Punch *F* also raises the little boss *k* on the work, which will be seen between the two lugs *i* and *j*. Punch *G* carried by the upper die-plate enters the small hole at the center of work *D* and draws down a cylindrical shell or bushing. It will, of course, be apparent that punch *G* works in conjunction with die *H*. The two small lugs *i* and *j* are raised on the work to provide bearings for the pivot of the swinging crank on the tape measure that is used for winding up the tape, while the shell drawn down from the small center hole forms the bearing for the main spindle of the tape measure to provide for securing the winder in place on this spindle.

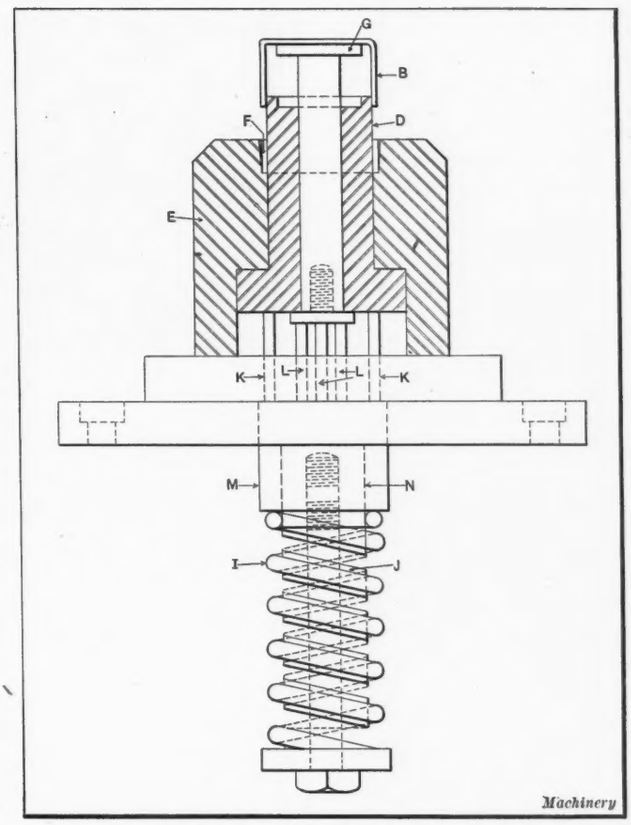


Fig. 3. Cross-sectional View of Die shown in Fig. 2, illustrating Method of Operation

The final operation involved in the production of this tape-measure winder is performed by the duplex die shown in Fig. 6. Between each stroke of the press one finished piece is removed from this die, and the piece on which one operation has been performed is transferred to the second member of the die ready for the final operation, while a fresh piece of work is set up on the first member of the die, which has thus been made ready to receive it. From this description it will be seen that for each stroke of the press one piece is completed, while the preliminary operation is performed on another shell. The work is shown at *E* before either of the two operations done in this die has been performed, and it is shown at *G* after the completion of the two operations.

Referring to Fig. 1, it will be seen that the work performed by the first section of this die consists of cutting a catch *k*, which is depended upon to hold the pivoted crank down in

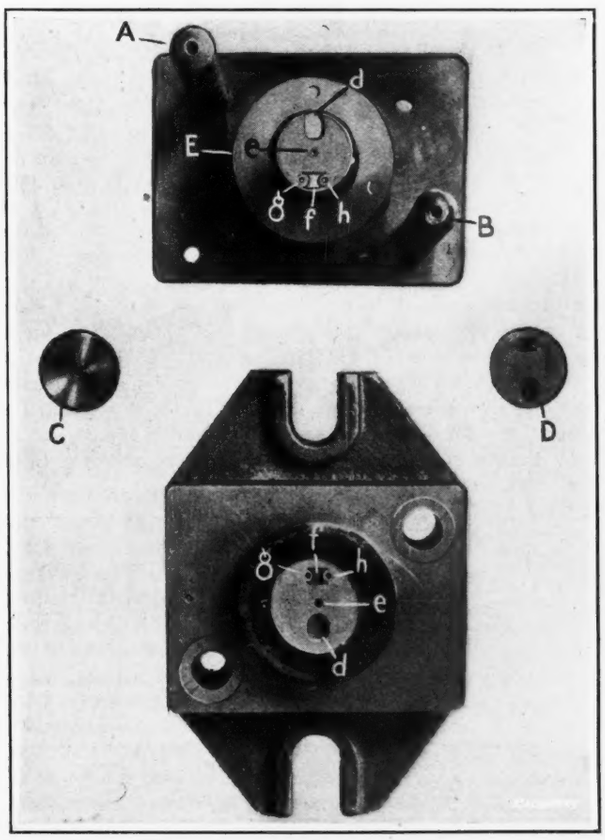


Fig. 4. Compound Die used for punching and piercing Holes d, e, f, g, and h

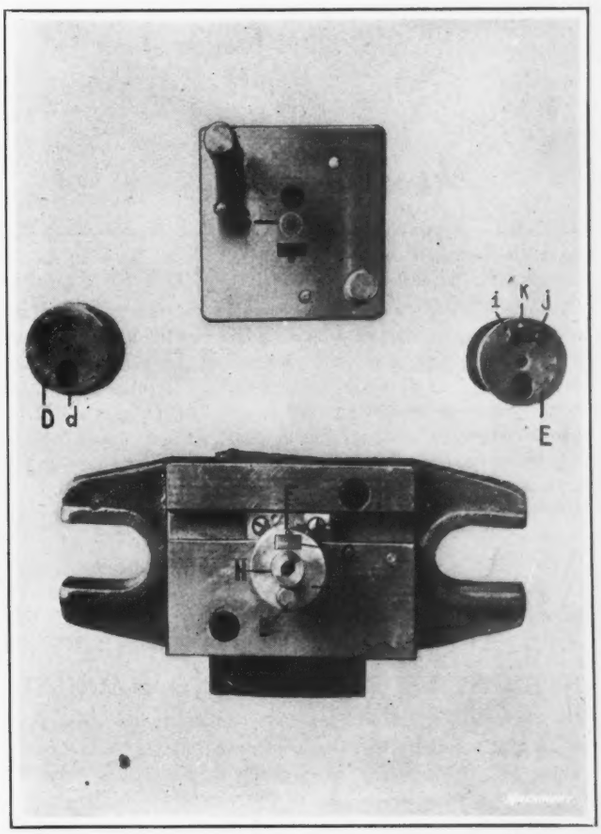


Fig. 5. Compound Die for bending up Lugs i and j, raising Boss k, and drawing down Shell around Center Hole

the body of the holder, this result being obtained by catch *k* springing down over the ball-crank handle on the winding crank. The other section of the die is depended upon to cut two notches *l* and *m* in the edge of the shell, leaving a central portion *n* to which the inner end of the tape measure is secured. With this preliminary statement, we are ready to turn our attention to Fig. 6, where it will be seen that these operations are performed by a die of relatively simple design. The work is first dropped into place over holder *A* on the lower die member, with the position of hole *d* directly over clearance space *B*, so that punch *C* may stamp out catch *k*, as shown at *F* in Fig. 1. At the same time that this is being done a piece of work, which has already been operated on by die section *A*, Fig. 6, and then transferred to die section *D*, where it is located by pilot *H* that enters hole *d* in the work, is operated upon by punches *I* and *J* to cut the notches shown at *l* and *m* in Fig. 1, thus leaving a lug *n*, to which the end of the tape measure is secured. It will be seen that the upper die is piloted into the lower die to secure the necessary alignment.

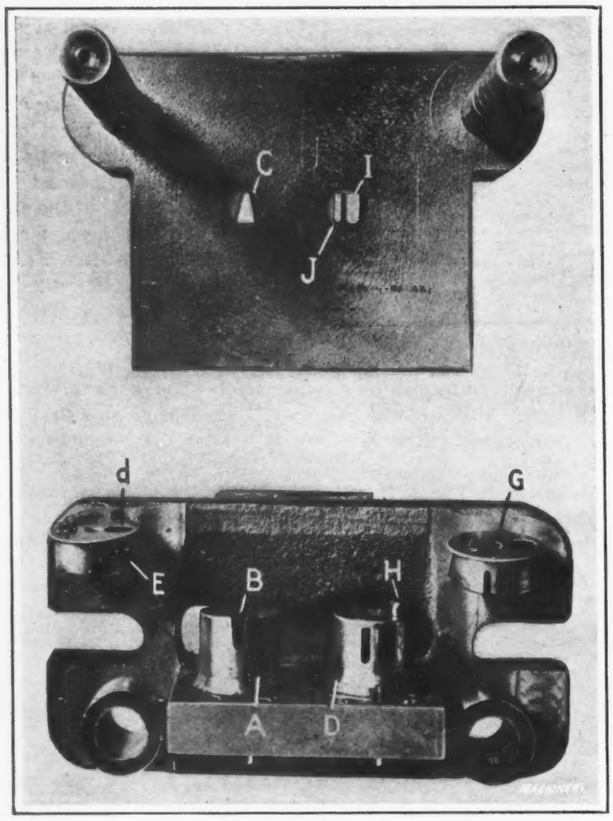


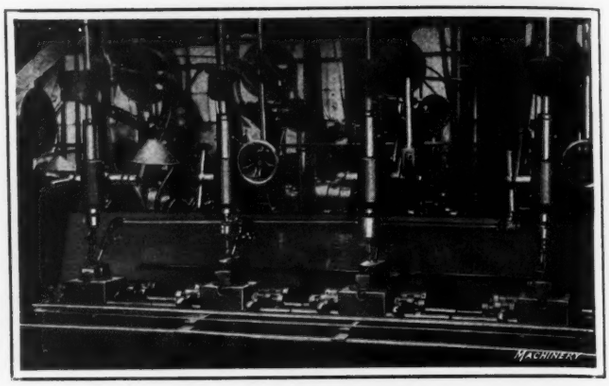
Fig. 6. Duplex Punch and Die for cutting Catch k and Notches l and m to leave Post n, to which Inner End of Tape is secured

Obviously, with a set of tools constructed along these lines, the cost of producing the finished winder will be a great deal less than when a shell is drawn up under the power press, and parts *a*, *b*, and *c*, shown at *A* in Fig. 1, are turned out independently and soldered onto the work. Not only is there the expense connected with the production of these pieces in automatic screw machines and by other methods, but there is also the cost of labor required to secure them in place on the winders. The dies which have been described in this article were made for the Crogan Mfg. Co., of Bangor, Me., for use in connection with the production of a tape measure which that company is about to place on the market. Patents have been applied for on certain features of this winder. E. K. H.

* * *

INTERESTING DIE DRILLING MACHINE

The four-spindle drilling machine shown in the accompanying illustration drills the two clearance holes and the center hole in the "Little Giant" dies made by the Wells Bros. Division of the Greenfield Tap & Die Corporation, Greenfield, Mass., very rapidly. The first two spindles drill the clearance holes, the third spindle drills the center hole, which is to be



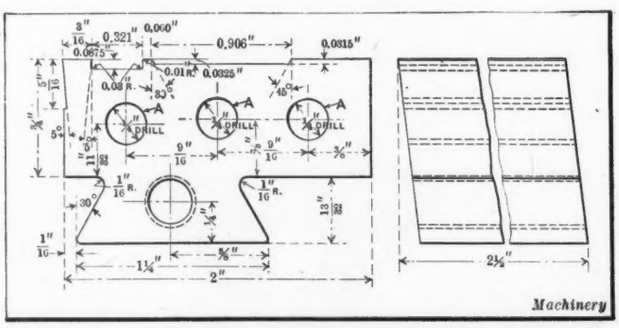
Arrangement for drilling Dies on Four-spindle Machine

threaded, and the fourth spindle reams the center hole preparatory to the cutting of the thread. The jigs in which the dies to be drilled are inserted are held in place by stops provided with handles, which may be seen on each side of the fixtures immediately on top of the bed. When these stops are swung up, the jig can be slid along to the next drill, where it is moved up against the stop and clamped in position. The stops are adjustable for different sizes of dies and are so adjusted that each of the holes will be drilled in the correct position. Stationary bushings are provided beneath the drill in small brackets held to the frame of the machine. As the holes are drilled in the various parts, the operator throws up the stops, moves each jig along one step, takes the last one from the table, and removes the finished piece. While the holes are being drilled in the other pieces, he inserts a new piece in this jig and starts it at the first spindle, so that the work is continuous. Of course, five jigs are required for four spindles, as one jig is always out of the machine for replacing the finished piece with a new one. This method can be applied to many other pieces where several holes must be drilled in an exact location relative to one another. This method is also easier for the operator, as he does not have to lift the jigs every time he moves them from one spindle to another.

* * *

PREVENTING WARPAGE AND BREAKAGE OF HIGH-SPEED STEEL TOOLS

In the Rockwell-Drake division of the Marline Rockwell Corporation, considerable trouble from warpage and breakage of small high-speed steel forming tools was experienced until the cause was determined and a method devised to prevent this loss. The class of work done by this division requires a large number of high-speed steel forming tools of the dovetail holder type, like the one shown in the accompanying illustration. The tool shown is used in forming the gas cylinder of a Browning machine gun. Formerly, tools of this kind were made solid and from 25 to 50 per cent were lost through cracking in the corners of the dovetail or warping on the tool faces. This trouble was found to be due to the ununiform area of the forming tool which resulted in uneven expansion when heated and uneven contraction when quenched. To overcome this difficulty, holes *A* were drilled through the forming tools so that the area of the surface to be heated and quenched was of a more uniform thickness. This entirely eliminated the trouble.



High-speed Steel Forming Tool which is drilled to prevent Warpage and Breakage in Hardening

HEAT-TREATMENT OF BRITISH HIGH-EXPLOSIVE SHELLS AND SHRAPNEL[1]

The 18-pound British shrapnel is forged from blanks cut from 3½-inch plain rolled steel bars, the analysis being carbon, from 0.48 to 0.6 per cent; manganese, from 0.5 to 1 per cent; silicon, under 0.3 per cent; phosphorus, under 0.06 per cent; and sulphur, under 0.05 per cent. The elastic limit of the bars is 19 long tons, with an ultimate breaking strength of at least 35 tons and an elongation of 20 per cent in 2 inches. After heat-treatment, the forging must meet the specifications in the finished shell, which are a yield point of 36 long tons, an ultimate breaking strength of 56 long tons, and a minimum elongation of 8 per cent in ⅝ inch. The test piece for determining these physical requirements is taken from the shell after it is partly finished and heat-treated.

After the forgings are rough-turned on the outside and finished on the inside, they are put on end in an oil-fired furnace that has a heating chamber about 36 inches square and has the combustion chamber underneath the heating chamber. The furnaces are equipped with pyrometers for temperature regulations. The 0.48 to 0.54 carbon heats are slowly heated to from 1600 to 1700 degrees F. and quenched in soluble oil. The shells are again heated in a similar furnace to from 950 to 1000 degrees F., withdrawn, and cooled in the open air. The 0.55 to 0.6 carbon heats are heated to from 1500 to 1600 degrees F., quenched in oil, and then reheated to from 1000 to 1350 degrees F., withdrawn, and cooled in the air. The higher the carbon, the higher is the temperature used in the second heat-treatment. The open end is then suspended in a metal bath with a temperature of approximately 1100 degrees F., for the purpose of closing in the nose end. After this is done in a press built for this purpose, the nose ends are buried in flake mica so as to be thoroughly annealed. The shell is then ready for the test piece to be cut out and the physical properties determined. By following this heat-treatment, it is seldom necessary to give a second complete heat-treatment to a heat of forgings.

Heat-treatment of British High-explosive Shells

The British high-explosive shells have the following chemical analysis: Carbon, from 0.4 to 0.55 per cent; silicon, from 0.15 to 0.35 per cent; manganese, from 0.6 to 1 per cent; sulphur, from 0 to 0.05 per cent; phosphorus, from 0 to 0.05 per cent. The physical properties are a minimum yield point of 19 long tons, a breaking strength of between 35 to 49 long tons inclusive, and an elongation of between 14 and 30 per cent in 2 inches. The forgings are annealed, normalized, or air-cooled. Those that are annealed are the high-carbon heats that have failed on account of too high an ultimate strength, or too low an elongation or both. The normalized forgings are those that have failed physically and do not pull according to their chemical analysis, which may be due to improper cooling or overheating, and also low-carbon heats that have not quite high enough a yield point or which fail in both ultimate strength and yield point. Heats that are air-cooled are those with too low a yield point and ultimate strength.

As a rule, the annealed heats are heated to 1600 degrees F., held at that temperature for a short time, and then cooled in a closed furnace; this reduces the average ultimate strength 3.2 long tons and increases the average elongation 2 per cent. The normalized forgings are heated to 1500 degrees F., taken from the furnace, and allowed to cool in the air.

Forgings that require air-cooling contain less than 0.44 per cent carbon. In the Sanburg air-cooling treatment, the forgings are heated in a continuous furnace to 1550 degrees F. and then placed on a pair of rollers that make thirty or forty revolutions a minute. As the forgings are revolved, a perforated pipe sprays the inside with air having a pressure of about twelve ounces, while three pipes spray the outside. This treatment cools the forgings from 1550 to 800 degrees F. in about seven minutes and raises the average ultimate strength 3.6 long tons, reduces the elongation 0.6 per cent, and brings the yield point above 19 long tons.

[1] Extract from a paper read before the Steel Treating Research Society at Detroit, Mich., by J. M. Hall, superintendent of the Hamilton Steel Wheel Co., Hamilton, Canada.

AIR FEED ON TURRET LATHES

The compressed air feed for turret lathes as shown in Fig. 1, is an entirely automatic, yet very simple, effective and inexpensive device. The illustration shows a Bardons & Oliver machine at work in the Columbus Brass Co.'s shops at Columbus, Ohio. This concern has used the air feed attachment with satisfaction for nearly eight years. The rods being machined are about 14 feet long.

Directly in line with the lathe spindle, extending to the rear, is a piece of Shelby tubing, large enough in diameter to allow easy movement for the rod, and extending about a foot

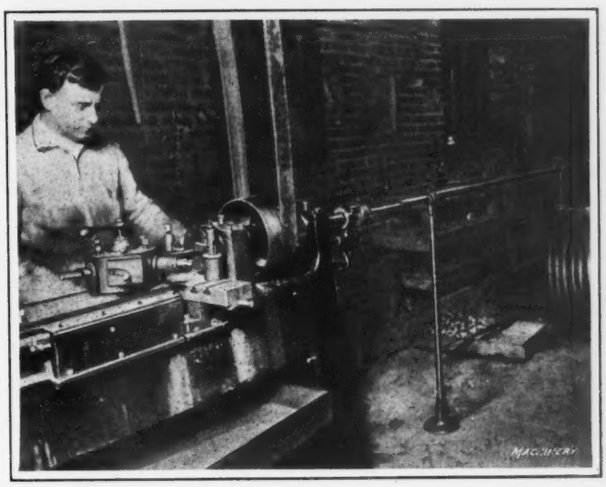


Fig. 1. Turret Lathe provided with Pneumatic Rod Feed

beyond the end of the rod when it is held in the chuck. The tubing is supported by standards as required, and equipped at the rear end with an easily detached air coupling. One other part is required—a cold-rolled steel plunger, to one end of which a leather gasket is attached. The plunger fits loosely in the tubing, while the gasket, of course, is tight. The operator loads the lathe by pushing the rod through the tubing into the chuck, sliding in the plunger with the gasket outward and quickly coupling the air tube to the Shelby tubing. He then turns on the air, producing a constant pressure on the rod of twenty pounds per square inch, which forces it forward until it reaches the stop on the turret head. The rod is then chucked and ready to be machined.

To advance the rod, preparatory to starting a new piece, the operator simply releases the chuck, keeping the stop in its

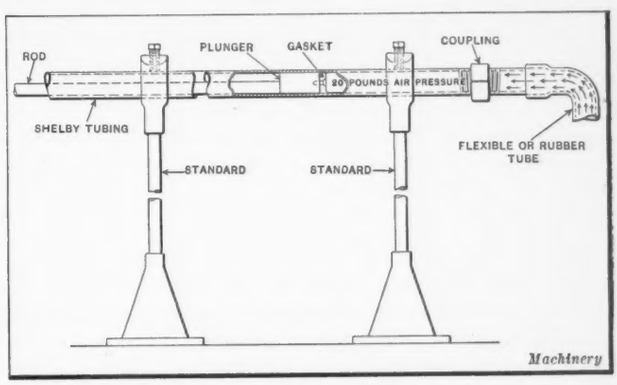


Fig. 2. Details of Pneumatic Rod Feed

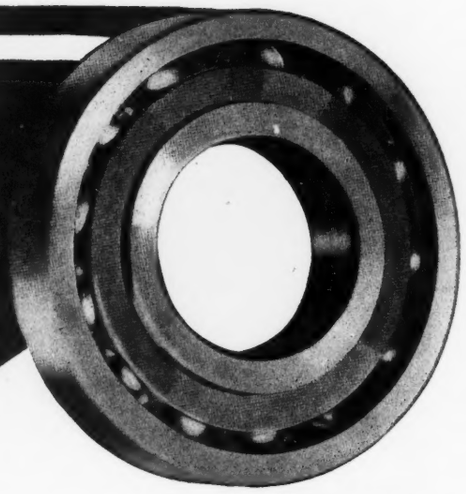
proper position, and the rod immediately advances to it. The lathe here shown is also equipped with an air chuck; hence the stock is both held and fed by air.

* * *

A few years ago all molds for brass and bronze were dried, but at present only those for brass castings with large areas are dried. In some cases, good results are obtained by drying one side only, the other side being entirely green. It has also been found that castings with deep borders or high ornaments can be made cleaner and sharper by pouring face side up.—*Transactions of American Institute of Metals*

Ball Bearings for Machine Shop Equipment—2

By Edward K. Hammond[1]



IN the first installment of this article, describing the use of ball bearings in machine shop equipment, a general discussion was presented of the basic principles which must be observed in designing ball bearing mountings and providing for lubrication of the bearings. It is of vital importance to observe all these principles carefully in order to obtain satisfactory service. After learning of the requirements which must be fulfilled by a ball bearing mounting, readers of this article will undoubtedly be interested in the methods used by representative machine tool builders in applying this type of anti-friction bearings in their product, and it is the purpose of the following article to illustrate and describe the ways in which ball bearings are applied in various types of machine tools and shop equipments.

Ball Bearings Used to Support Grinding Machine Spindles

In order for the abrasive to cut efficiently, it is necessary for grinding wheels to be driven at a peripheral speed of about 5000 feet per minute. The attainment of this cutting speed requires the spindles of grinding wheels to run at high speed, and this is particularly true in the case of internal grinders, because the small diameter of the wheel often calls for a very high speed of rotation in order to bring the peripheral speed up to 5000 feet per minute. Ball bearings are particularly suited for operation at high speed because their freedom from frictional resistance practically eliminates trouble which might otherwise be experienced through rapid wear of the bearings or through trouble from bearings tending to become heated while in use.

Fig. 7 shows the design of mountings for Gurney ball bearings used to support the spindle of a grinding machine. The point of exceptional interest in connection with this design is the provision for constantly maintaining a tight fit between the balls and races of the bearings, and for retaining oil in the bearings and excluding dirt and other foreign matter. Owing to the high speed at which grinding machine spindles are required to operate in order to maintain an efficient cutting action for the abrasive wheel, any lost motion in the bearings would result in vibration and production of chatter marks on the work. To avoid this trouble, a sleeve *A* is provided which extends over the outer race of the bearing. At the right-hand side, this sleeve is bored to such a diameter that the outer race of the ball bearing is a sufficiently loose fit so that it can gradually creep around in the sleeve. At the left-hand side there are bores to receive compression springs *B*, which provide for pushing the sleeve *A* over so that the shoulder on this sleeve, which abuts against the outer race, forces this race toward the right. As a result of this tension applied by springs *B*, a tight fit is constantly maintained between the balls and races of the bearing.

On this machine an ingenious provision is made for retaining lubricant in the bearing mounting and excluding dirt and other foreign matter. This form of sealing device was developed by the Gurney Ball Bearing Co. and has given very satisfactory results under severe conditions of service. The device consists of two sets of spiral grooves *C* and *D*, which are cut right- and left-hand, respectively. As the spindle rotates at high speed, groove *C* tends to carry the oil back into the bearing, while groove *D* exerts a similar effect in excluding any abrasive dust or other matter which would seriously damage the balls and races if it found its way into the bearing. In designing a mounting of this kind it is important to note that the spiral grooves are always cut in the inner member, in order that centrifugal force may not have the effect of forcing the oil or dirt into the grooves machined in the concave surface of the outer member and cause the grooves to become clogged. Attention is called to the fact that the same form of sealing device is provided at each side of the ball bearing at the left-hand end of the spindle.

Bearing Design for Van Norman Radial Grinding Machines

On ball race grinding machines built by the Van Norman Machine Tool Co., Springfield, Mass., an interesting form of mounting has been developed. Reference to Fig. 8, which shows a cross-sectional view of the quill assembly for a No. 3½ ball race grinder, will make it apparent that there are two ball bearings of the type made by the Norma Co. of America, 1790 Broadway, New York City, at each end of the spindle. These bearings and the spindle are carried in an enclosed case, which is kept partially filled with oil by replenishing the supply through an opening *A* provided for that purpose. Gage-glass *B* enables the machine operator to readily see that the oil is up to the line marked on this glass to show where the level of lubricant should be maintained. The two ball bearings at the left-hand or wheel end of the spindle are so placed that the lower balls in each bearing are submerged in the oil, and in this way a complete lubrication of these two bearings is assured. The bearings at the opposite end of the spindle are located at a higher level and they would not receive an adequate supply of oil unless special means were taken to assure obtaining the desired result. For this purpose a notched disk *C* is mounted on the spindle in such a way that the bottom of this disk dips into the oil. As the spindle revolves at high speed, disk *C* acts as a "thrower" which picks up oil from the reservoir and through the action of centrifugal force throws it off in such a way that a portion of the oil is collected in trough *D*. From this trough the oil flows down into the ball bearings at the right-hand end of the spindle, and after circulating through these bearings it drips back into the reservoir. In this way adequate lubrication is assured.

Mention has been made of the fact that the ball bearings in which this spindle is carried are of the Norma type in which provision is made to compensate for wear. It will be seen that the inner races of these bearings are provided with the usual form of ball grooves, but that the outer races are ground with a combined straight and radial surface, with the ball normally contacting at the junction of these surfaces. When it is found that the balls or races of the bearing have been worn sufficiently through service so that there is an appreciable amount of lost motion, compensation can be made by adjusting the bearing race in such a way that the line of contact

[1]Associate Editor of MACHINERY.

over which the balls run in the race is slightly higher up on the curved surface. This adjustment is made in the present case by grinding a sufficient amount from the face of one of the bearings at D_1. At the right-hand end of the quill it will be seen that the method of compensation is similar. The faces of the bearings as at D_1 in both front and rear sets are clamped and held firmly together, those at the front being held in position by the nut E, and those at the rear by nut H. A floating container I, in which the rear bearings are secured, furnishes provision for endwise expansion and contraction of the spindle. A sealing nut G closes the rear end of the casing.

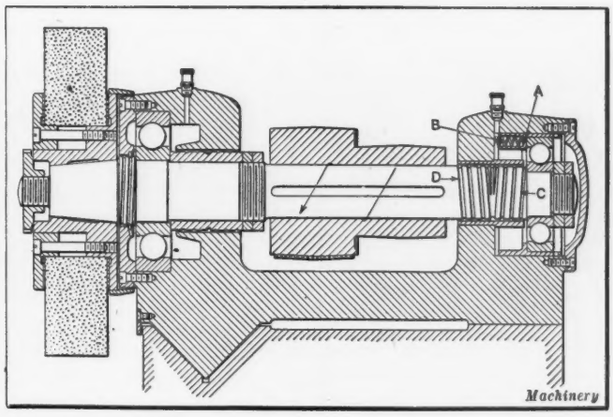


Fig. 7. Mountings for Ball Bearings for Grinding Machine Spindle

In the case of the ball bearing mounting shown in Fig. 9, features of the design are essentially the same as those which have just been described, except it will be seen that a plain bearing is furnished at the front end of the spindle. This bearing is located above the level of lubricant contained in the quill, and in order to deliver lubricant to this bearing, a notched disk A and trough B are employed, the disk throwing oil into trough B, down which it runs onto a felt packing C, from which a supply of oil is constantly delivered to the plain bearing that carries the spindle. It will be seen that means are provided to compensate for any wear which develops in this plain bearing. The ball bearings at the opposite end of the spindle dip into the oil reservoir to provide for their lubrication.

In Fig. 10 there is shown a type of mounting developed by the Fafnir Bearing Co., of New Britain, Conn., for use in supporting the spindle of grinding machines which are employed for the performance of internal grinding operations on ball bearing raceways. The bearings used for this purpose are of the Fafnir open or "magneto" type, which are particularly well adapted for use in carrying machine tool spindles where a perfectly tight fit is required, because these bearings may be adjusted to compensate for wear. When a ball bearing is new, the surfaces of the raceways and balls are covered with minute scratches left by the abrasive, and although the bearing may be a perfectly tight fit before it is placed in operation, the application of pressure on the bearing causes these scratches to be rolled down to form a smooth bearing surface, with the result that a slight amount of lost motion is introduced. Wear may progress no further, but the slight amount of play developed in this way will seriously impair the accuracy of work which can be produced on a machine with its spindle supported in bearings that are in this condition. With the Fafnir magneto type bearing, the outer race may be adjusted longitudinally in relation to the inner race, thus tightening the fit of the races on the balls and effectually eliminating all play in the bearing. After this adjustment has been made, the bearing will frequently run for a long period of time without requiring attention. The lost motion is introduced as a result of flattening out the scratches on the surfaces of the bearing and balls, and not through the occurrence of wear, as the term is commonly understood. Bearings of this type have run for over a year, operating ten hours a day, at speeds ranging from 18,000 to 25,000 revolutions per minute, without giving any trouble.

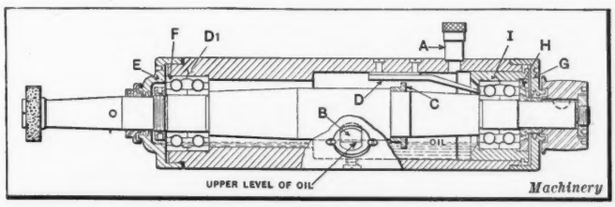


Fig. 8. Design of Mountings and Provision for lubricating Ball Bearings on Internal Grinding Machine Spindle

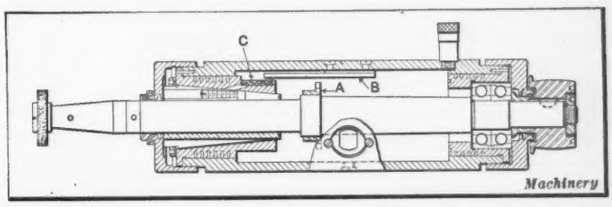


Fig. 9. Design of Mounting and Provision for lubricating Ball Bearing and Plain Bearing on Internal Grinder

Adjustment of these bearings to take up lost motion is accomplished by tightening caps A, which force the outer races inward, thus causing the balls to engage the races at a point higher up on their curved shoulders. Some designers have formed a prejudice against the use of adjustable ball bearings, probably owing to a recollection of the extremely unreliable service obtained from the adjustable cup and cone type of ball bearings which were used in the bicycle. Much of the trouble experienced with these bearings was due to the fact that they were made from unsuitable material and that adjustment was often made by people with no mechanical training. If an adjustable ball bearing is improperly handled, it is likely that the bearing will be made too tight and thus be damaged. In adjusting a bearing of the type shown in Fig. 10, the proper method of procedure is to tighten collars A a slight amount at a time, testing the accuracy of the spindle with an indicator between the successive tightenings until the collars have been screwed up just enough to eliminate all lost motion in the bearings and assure the spindle running true, as shown by the use of an indicator. Where this method of procedure is followed, adjustable bearings can be used with a reasonable degree of assurance that they will give satisfactory results. Their adjustment by skilled mechanics using scientific instruments is in no sense comparable to the results obtained by laymen who attempt to adjust the bearings of bicycles without having any definite knowledge of the result they are trying to accomplish or instruments to tell them when the desired condition has been attained.

In Fig. 11 is shown another example of a ball bearing mounting for an internal grinding machine spindle. The present illustration shows a design developed by the S K F Ball Bear-

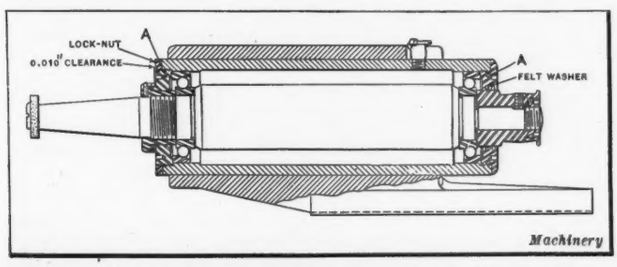


Fig. 10. Internal Grinding Machine Spindle mounted in "Magneto" Type Ball Bearings with Adjustment for Wear

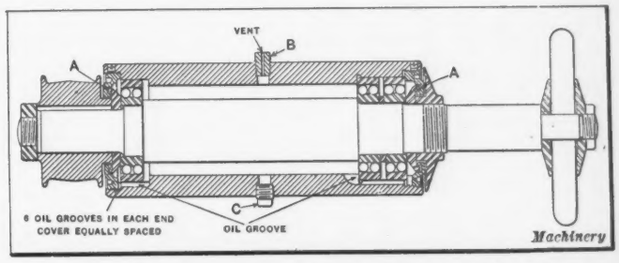


Fig. 11. Design of Mounting for Internal Grinding Machine Spindle, showing Provision of Flooded Lubrication

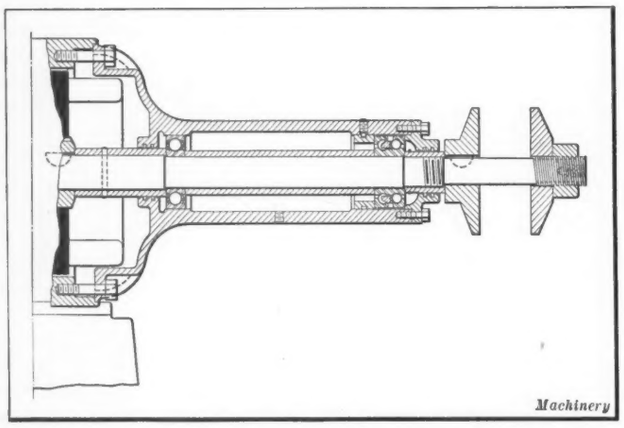


Fig. 12. One End of Double-wheel Grinding Machine Spindle mounted in Ball Bearings. Note Use of Double-row Bearing at Outer End of Spindle

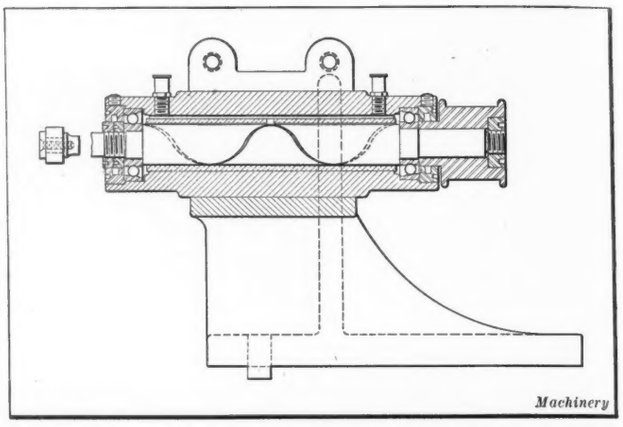


Fig. 13. Design of Ball Bearing Spindle Mounting for Internal Grinding Attachment used on Universal Grinder. Provision is made for Adjustment of Bearings

ing Co., of Hartford, Conn., in which double-row radial ball bearings of this firm's manufacture are used to support the spindle of a machine used for grinding ball raceways. Attention is called to the fact that at the front end of the spindle, where the greatest load has to be carried, two ball bearings are provided, while a single bearing is depended upon to support the spindle at the rear end. Points of interest in connection with this design are the provision made for excluding abrasive dust and other forms of foreign matter from the bearings, the means of replenishing the oil supply in the reservoir in which the bearings and spindle are contained, and the means of cleaning out this reservoir when necessary. First, let us turn our attention to the ball bearing mountings. Here the point of particular interest is the provision of so-called "labyrinth" seals *A* to provide for the exclusion of abrasive dust, etc., from the bearings. It will be seen that each seal is composed of two members, one of which is provided with a tongue which fits into a groove in the other member of the sealing device. The labyrinth formed in this way gradually becomes filled with oil, making it practically impossible for any foreign matter to find its way through into the bearings where it would cause trouble by rapidly increasing the rate at which wear takes place. The supply of oil may be replenished by removing cap *B* to give access to the oil-hole. At the bottom of the reservoir it will be seen that there is a threaded plug *C*, which may be removed in order to drain out the dirty oil and provide for flushing the case with kerosene before a fresh supply of lubricating oil is introduced.

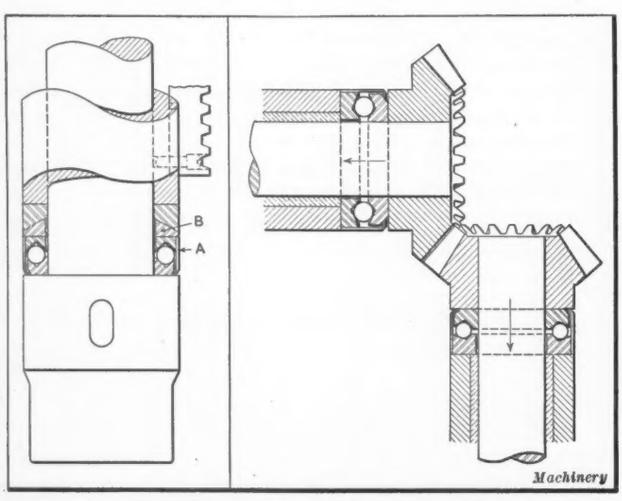
Mounting Polishing Lathe Spindles in Ball Bearings

In Fig. 12 is shown a motor-driven double-wheel polishing head, built by the Webster & Perks Tool Co., of Springfield, Ohio, in which the spindle is carried by ball bearings. The method of mounting the ball bearings which has been adopted by this company is quite simple, and after having read previous descriptions, the reader will readily understand the features of this installation from the illustration. The interesting feature is that two ball bearings made by the New Departure Mfg. Co., Bristol, Conn., are used at each end of the machine, one of which is a single-row radial bearing, while the other is a double-row combination radial and thrust bearing. This combination of bearings provides for efficiently supporting both the radial and thrust loads of the spindle.

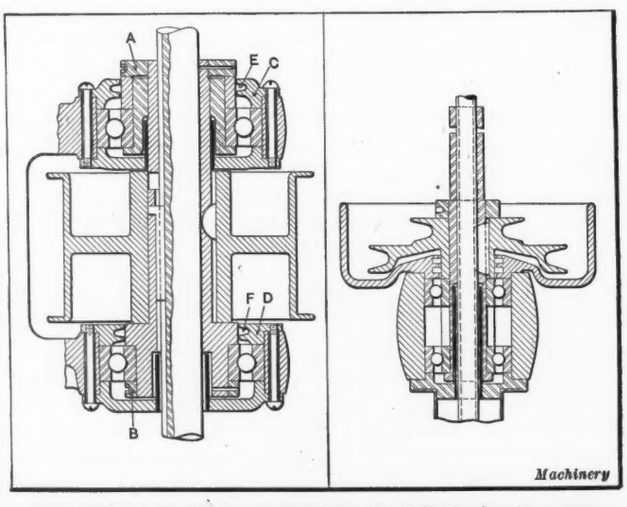
For use on the Webster & Perks Tool Co.'s universal grinding machine an internal grinding attachment is furnished, which is shown in Fig. 13. The spindle operates at speeds varying from 15,000 to 20,000 revolutions per minute. These attachments are designed for tool-room and light manufacturing duty; manufacturing spindles slightly heavier are also furnished for continuous-production work. They are carried in Norma ball bearings, giving a rigid mounting to both ball races. All axial play is removed. The inner races are secured against shoulders on the spindle by lock-nuts, and the outer races are moved into position on the first assembly by the threaded cover plates shown. Set-screws secure these cover plates in position. After the first assembly of these bearings, no subsequent adjustment is necessary. To users, this is an interesting and important consideration. Abrasive dust is prevented from entering the bearings by the provision of felt washers, and lubrication is effected through the oilers shown. At these high speeds it is recommended to use a light-bodied mineral oil, free from acid or alkali. Only a few drops of oil a day are required; excess lubrication is undesirable.

Application of Ball Bearings in Drilling Machines

Ball bearings are widely used on drilling machines both for supporting spindles and driving shafts. On the spindles, ball thrust bearings are used to excellent advantage in place of various forms of collars that have been employed to carry the thrust load. This was one of the first applications of ball



Figs. 14 and 15. Application of Self-aligning Washers behind Ball Thrust Bearing on Drilling Machine Spindle, and Ball Thrust Bearings behind Bevel Crown Gears



Figs. 16 and 17. Design of Mountings for Ball Bearings to carry Spindle Pulley on High-speed Drilling Machine and Spindle of Machine

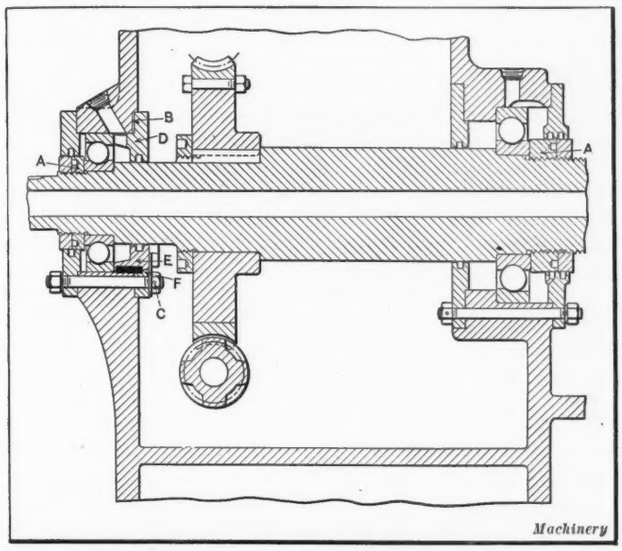


Fig. 18. Heavy-duty Shell-boring Lathe with Spindle mounted in Combination Radial and Thrust Ball Bearings with Provision for making Adjustment for Wear

bearings in the machine tool field. At the present time, it is recognized that marked advantages are obtained through the performance of drilling operations at very high speeds, and it is largely owing to the application of ball bearings for carrying the spindles that use of such speeds is made practicable. When properly lubricated, ball bearings operate with very little friction, and so they can be run at speeds which would be excessive for plain bearings, without any danger of the ball bearings showing excessive wear or a tendency to become heated as a result of frictional resistance.

Ball Thrust Bearing for Drilling Machine Spindle

In Fig. 14 is shown a partial cross-sectional view of a drilling machine spindle equipped with a ball thrust bearing of the type made by the Auburn Ball Bearing Co., of Rochester, N. Y. This type of bearing is assembled with a sleeve *A* over the outside of the races, which serves the double purpose of holding the bearing together, so that it constitutes a single unit that is easy to handle, and of keeping dust and other foreign matter out of the bearing, thus protecting it from damage. Attention is called to the fact that spherical-seated collars *B* are placed behind the upper race, so that any lack of alignment is easily taken up by movement of these collars on their spherical seat, thus assuring no unnecessary strain being imposed upon the ball bearing. It has been the experience of drilling machine builders that the spindles may be machined so true that these spherical-seated aligning collars are not really necessary. A bearing of this type will easily carry all the thrust load that is imposed upon a drilling machine spindle under any normal conditions of operation without cramping and without in any way impairing the sensitiveness of the machine. It will be seen that the lower race is a tight fit on the spindle, while the upper race is free. Fig. 15 shows the application of the same type of ball bearings for supporting the thrust of bevel crown gears on a drilling machine.

Fig. 16 shows the method of mounting the spindle pulley of a high-speed drilling machine built by the Leland-Gifford

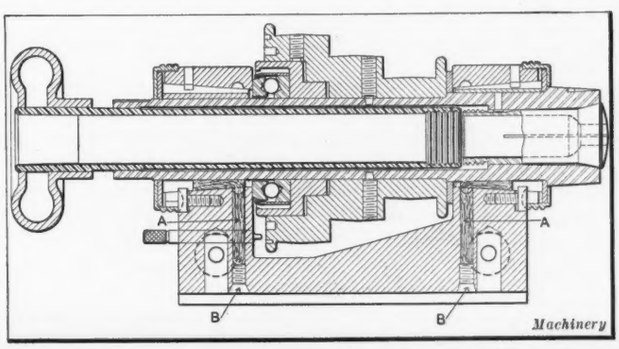


Fig. 19. Application of Ball Thrust Bearing to carry the Thrust Load on a Bench Lathe Spindle

Co., of Worcester, Mass., in ball bearings to provide for operation at 3500 revolutions per minute. In making this application of ball bearings, the company states that the important points to observe are as follows: First of all, great care should be taken to have the outer ball bearing race loose, so that it can run freely; this race must not be tight or caused to bind, for any reason. Next in order of importance is to have the bearing carefully enclosed so that it may be packed in grease and so that foreign matter is excluded. The bearings should be cleaned at intervals of six months and packed with a fresh supply of grease. It is also highly important to use a "neutral" grease which is neither acid nor alkaline. Attention is called to Fig. 16, where it will be seen that the sleeve around the shaft is designed to come up beyond the top of the ball bearing, thus forming a space which may be packed with a sufficient supply of grease to last for six months. It is highly important for the inner race to be firmly clamped so that it will not have any tendency to move on the shaft. This result is obtained for the upper ball bearing by means of a threaded collar *A*, while a threaded collar *B* performs the same function on the bottom bearing. In each case it will be apparent that the sleeve which encloses the bearing is sealed by means of

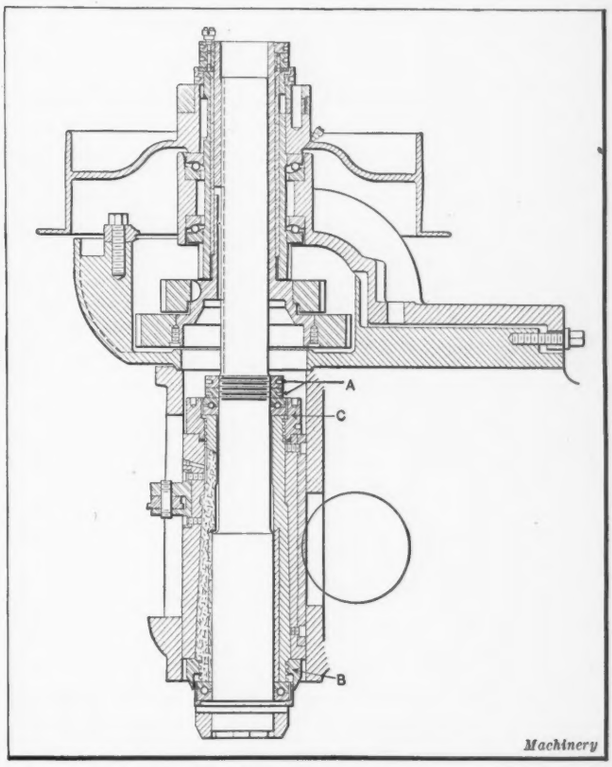


Fig. 20. Vertical Milling Machine Spindle equipped with Two Commercial Ball Thrust Bearings and Two Special Combination Radial-thrust Ball Bearings

caps *C* and *D*, respectively, and that these caps are provided with annular rings *E* and *F* which are filled with grease, thus forming a seal that excludes abrasive from the bearings. It has been the experience of the Leland-Gifford Co. that filling these grooves with grease instead of felt packing is the means of securing better results, because the grease is just as effective as a seal, and with felt fiber there is a tendency for the fiber to find its way into the bearing.

In Fig. 17 is shown the mounting for the spindle of a Leland-Gifford drilling machine which is designed for operation at speeds in excess of 10,000 revolutions per minute. To meet the requirements of this service, the spindle is mounted in radial ball bearings made by the Hess-Bright Mfg. Co., of Philadelphia, Pa. These bearings are enclosed in an oil-tight mounting, so that they may be packed in grease according to the method which has already been described.

Experience has shown that when fiber washers are used at the top of the drilling machine spindle in place of a ball thrust bearing, constant trouble is likely to be experienced from the wearing out of these washers and consequent development of end play, the result of which is to allow the drill to "hog in"

as it breaks through the work. In many cases—and particularly where very small drills are used—the sudden increase in the rate of feed which results from this hogging in is sufficient to cause the drill to be broken.

Use of Ball Bearings in Lathe Construction

Many manufacturers are using ball bearings to support the driving shafts on lathes, and some builders of these machines have been successful in devising methods of supporting the main spindle in ball bearings. It is certainly safe to state that a marked improvement in transmission efficiency and reduction of the amount of power required to drive a lathe are secured through substitution of ball bearings for plain bearings. A statement has already been made concerning the diversity of opinion in regard to the desirability of carrying machine tool spindles in ball bearings, but some lathe builders who have investigated the matter state that ball bearings give entirely satisfactory results in this service.

It is true that the apparent friction loss in a lathe spindle bearing is small and that the resulting power economy would not pay returns on the difference in the cost of plain bearings and anti-friction bearings. But this feature of machine design has another aspect to which designers, builders, and users of machine tools may profitably give earnest attention. It has been shown by tests that a ball bearing spindle may be made freer from chatter than a plain spindle working under the same conditions of load, and, as everyone knows, chatter is the foe of efficient metal cutting. The moment the work or tool begins to chatter, rapid deterioration of the cutting edges begins. The tool will soon break down and require removal and grinding. The loss of time resulting from regrinding the tool and resetting is an appreciable factor in the day's production.

Excessive chatter is usually noticeable when work is being done while held on a faceplate or in a chuck and without tailstock or steadyrest support. Then the whole pressure of cutting is transmitted to the spindle and spindle bearings. When the work has considerable overhang, the pressure of the cut on the front spindle bearing is considerably increased by the leverage of overhang. Under such conditions, the average mechanic would not think of trying to take a heavy cut with an ordinary engine lathe unless he provided either steadyrest or tailstock support. But if he were able to dispense with these supports, much time would often be saved in chucking the work and removing it when finished.

Tests on lathes built with extra-heavy spindles and ball bearings adequate for the work designed have shown that the spindle possesses remarkable anti-chatter characteristics. The reason is not obscure. This is due to the elimination of excessive friction in the bearings. When a lathe of ordinary design with plain bearings is subjected to the test of turning a piece held in the chuck with the end projecting several inches, the pressure of the cut is often sufficient to break down and squeeze out the oil film between the spindle and the bearings. The result is metal-to-metal contact and excessive frictional resistance. Chatter begins in the headstock bearing itself, and being transmitted to the work, is intensified, with the result that the tool point speedily breaks down. In view of this unsuspected cause of machine tool inefficiency, our conservative machine tool builders and users may find that they

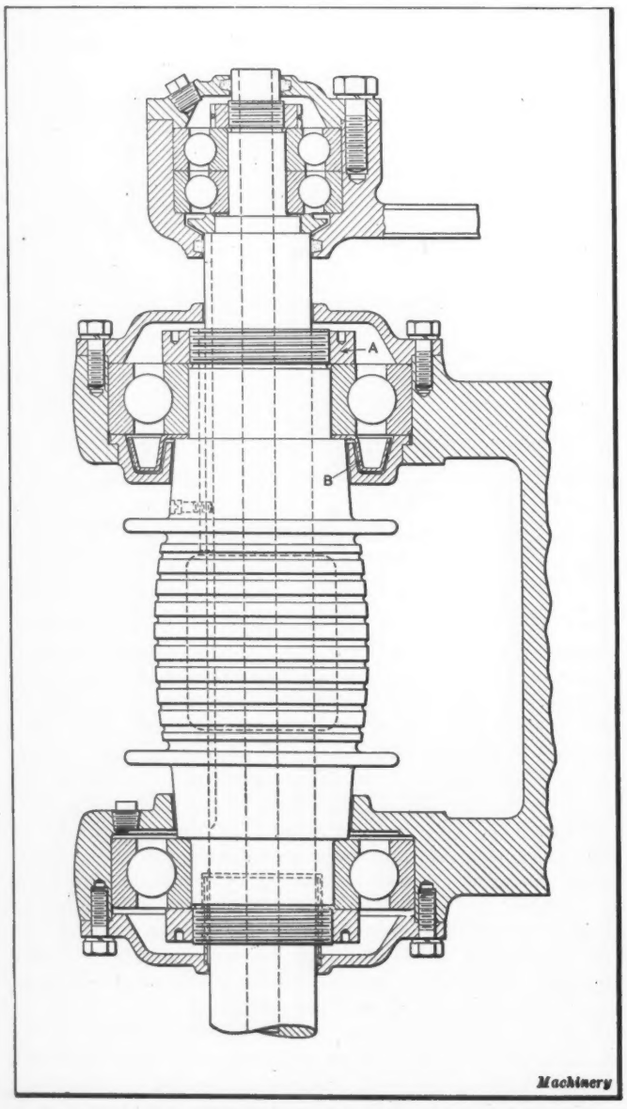


Fig. 21. Ball Bearing Mountings for Vertical Spindle of Wood Shaper, showing Oil-cup designed to prevent Escape of Oil

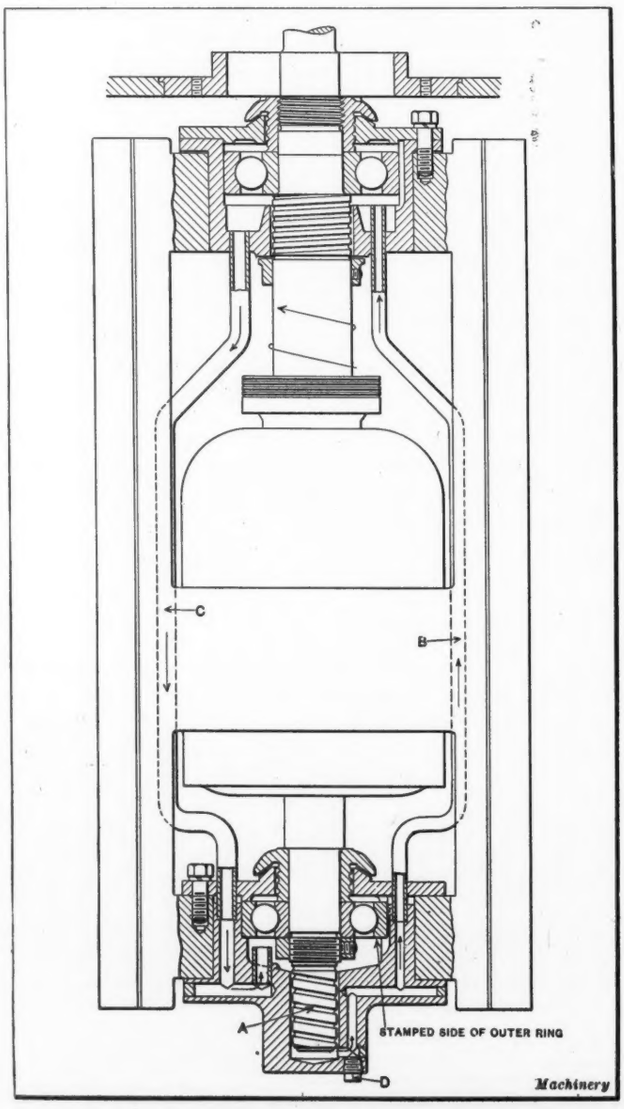


Fig. 22. Spiral Grooves on Spindle, providing for Circulation of Oil between Different Bearings

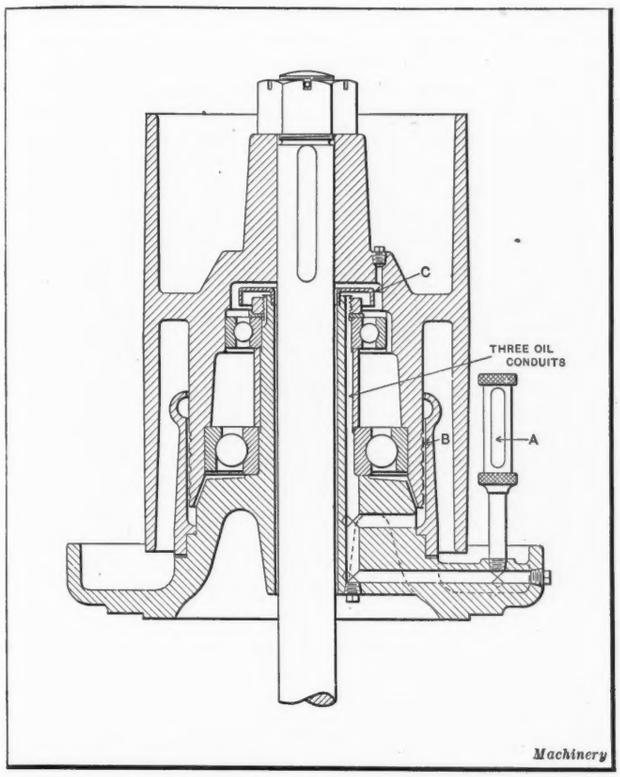


Fig. 23. Another Example of Spiral Groove affording Means for circulating Oil between Ball Bearings

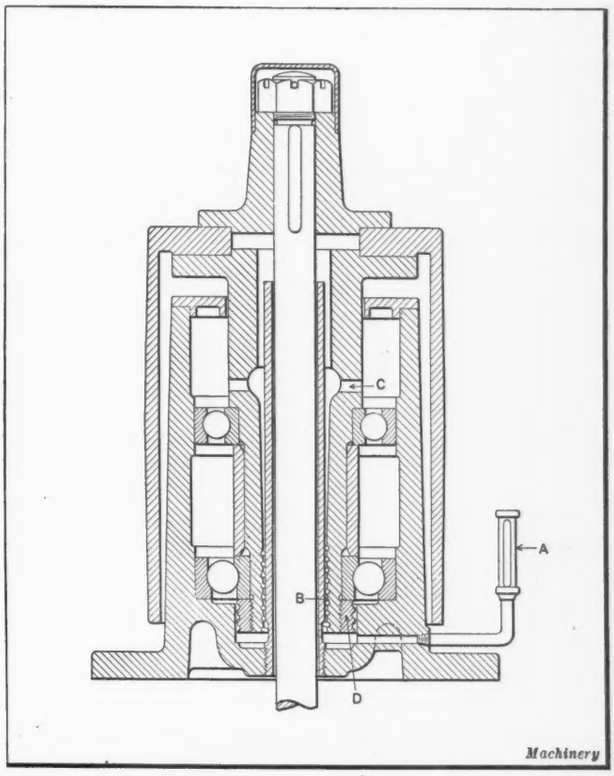


Fig. 24. Another Design of Bearing Mounting, the Purpose of which is to have Inner Race secured to Rotating Member

were mistaken in their estimate of the lack of possibilities of ball bearings in machine tools.

In Fig. 18 is shown the method of mounting in ball bearings the spindle of a heavy-duty shell-boring lathe which was built by the Hart-Parr Co., of Charles City, Iowa, for use in filling an order for British 9.2-inch high-explosive shells. The fact that these lathes operated satisfactorily with the spindles mounted in ball bearings seems to offer an adequate answer to the question concerning the possibility of securing accurate and well-finished work from machine tools with ball bearings used for carrying the main spindle. It is well known by mechanical men that the finish required on these high-explosive shells is extremely fine, and the shells are subjected to a most rigid inspection to see that they come up to all requirements. These requirements were fulfilled by the Hart-Parr lathes. The bearings are of the "radio-thrust" type made by the Gurney Ball Bearing Co., of Jamestown, N. Y., which are made with a capacity for carrying thrust loads ranging from 100 to 200 per cent of the capacity of the bearing for supporting radial loads. Evidently such bearings are exceptionally well suited for carrying the spindle of a boring lathe where there is bound to be a considerable thrust load. It will be apparent from the illustration that the bearing at each end is furnished with a clamping collar *A*, which binds the inner race to prevent it from rotating on the spindle. A lock-collar or nut is screwed up against each collar *A* to prevent it from rotating after it has been tightened up to the desired position. The way in which the bearings are mounted to provide for the exclusion of foreign matter and packing of the bearings with grease to insure efficient lubrication is quite clearly shown in the illustration, so that this feature does not call for further discussion. These bearings can be adjusted, and it is the opinion of the Hart-Parr Co. that they can be maintained tighter and more rigid than an adjustable bronze box with a variable oil film.

In Fig. 18 it will be seen that either of two methods may be used for adjusting the bearings to compensate for lost motion. One method consists of reducing the thickness of shim *B*, which may be accomplished either by grinding down the shim or by removing a lamination in case a laminated shim is employed. After adjusting the shim, bolts *C* are tightened to provide for drawing collar *D* against the outer race of the bearing. In this way, lost motion in both bearings is taken up because, after the bearing at the left-hand end of the spindle has been made a tight fit, the entire spindle will be drawn to the left, which results in pulling the inner race and balls of the right-hand bearing over sufficiently to insure a tight fit of the balls in this bearing between the inner and outer races.

By the other method of adjustment shown in Fig. 18, a threaded ring *E* is provided to fit inside the threaded section of collar *F*. By tightening ring *E*, the shoulder on this ring is pushed against the outer race of the left-hand bearing, thus tightening the fit of the balls in the races of this bearing; also, the entire spindle is drawn to the left, thus tightening the fit of the bearing at the right-hand end of the spindle in the same way as this result was accomplished through reducing shim *B* and tightening bolts *C*.

The front end bearing next to the work has a bore of 6.693 inches, an outside diameter of 13.386 inches, a width of 2.244 inches, and fifteen 1⅞-inch balls. The rear bearing has a bore of 4.331 inches, an outside diameter of 9.449 inches, a width of 1.968 inch, and fourteen 1½-inch balls. These two bearings take both the radial and thrust loads in each direction, there being no other thrust bearing or thrust collar on the spindle. The mounting of these bearings on the spindle is simple; the spindle may be taken out by removing the two end plates that are bolted on. An important feature of these radio-thrust bearings is that they are set up tight, there being no radial freedom whatever. This, of course, is quite different from the customary practice of setting up spindles in babbitt or bronze bearings. In plain bearings, radial freedom must be provided to allow for a film of lubricant between the spindle and the bearing.

It is claimed by some mechanical engineers that ball bearings when used on lathe spindles mark the work with annular waves, these being caused by the passage of the balls along the raceways in relation to the tool point. Some have gone so far as to suggest the use of a large number of small balls in order to reduce the distance between the balls to a minimum. But this expedient is unnecessary, as a properly constructed and designed ball bearing of sufficient capacity to carry the loads imposed on it will run perfectly smooth when applied to a lathe spindle. In the case of the Hart-Parr projectile lathe, it is claimed that the finish produced on the work is so smooth that it is not necessary to grind the shells afterward.

It is stated by the lathe maker that the spindle drives the heaviest cut without chatter. Repeated tests have been made on steel projectiles mounted on a mandrel screwed to the spindle nose and without tailstock support, which have demonstrated that the combination of worm drive, heavy construction, and anti-friction spindle bearings makes remarkable production results possible. Cuts one-half inch deep with one-sixteenth inch feed in 0.50 per cent carbon and 0.70 per cent manganese steel were taken without chatter at a distance of 36 inches from the front bearing, without the use of a tailstock support. A plain spindle subjected to such a test would doubtless have chattered, because the projected area of a plain bearing would not have been sufficient to prevent the oil film

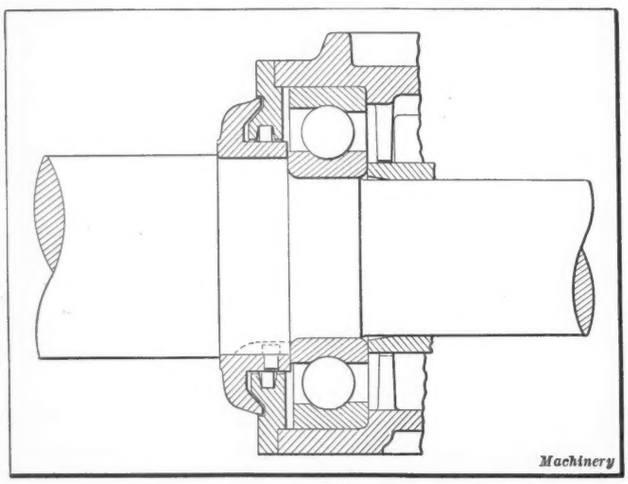


Fig. 25. A so-called "Grist-mill" Seal for Ball Bearings

from being broken down and displaced. The metal-to-metal contact of the spindle and bearing under heavy pressure would cause excessive friction and chatter. This cause of chatter in machine tools is often unsuspected, the fault being laid to other constructive features.

Thrust Bearing for Bench Lathe Head

In the bench lathes built by Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill., use is made of a ball bearing to carry the thrust of the spindle. The ball thrust bearings used for this purpose are made by the U. S. Ball Bearing Co., Chicago, Ill. Extending from the outside of the right-hand race there will be seen in Fig. 19 a sheet-brass guard which covers the space between the races so that the balls may be packed with grease. Not only is this the means of insuring efficient lubrication of the bearings, but it also excludes dirt, which would rapidly clog the action of the balls of a bearing mounted in the position in which this bearing is placed on the Hardinge bench lathe. The arrangement of the plain tapered bearings which support the spindle is also somewhat unusual, in so far as provision made for the lubrication of these bearings is concerned. Placed at the back of the lathe head, there are oil-cups which deliver lubricant to vertical pockets that are filled with felt wicks *A*. These wicks carry oil up to channels in the tapered bearings and serve the additional purpose of filtering the oil to insure the exclusion of any foreign matter which would cause rapid wear of the rubbing surfaces of the bearings. Occasionally it is necessary to clean out the oil reservoirs which supply oil to the bearings, and to facilitate this operation, threaded drain plugs *B* are furnished, which can be removed to provide for flushing the reservoirs with kerosene.

Application of Ball Bearings on Milling Machines

On vertical milling machines built by the Becker Milling Machine Co., Hyde Park, Mass., four ball bearings are employed to support the spindle. The two lower ball bearings are for carrying end thrust, and these are of the type made by the Ball & Roller Bearing Co., of Danbury, Conn. It will be seen in Fig. 20 that the lower end of the spindle is supported radially by a tapered plain bearing. At the upper end of the spindle there are two ball bearings of a special type made in the Becker shops. These are a combination radial and thrust bearing, and owing to the form of the raceways, adjustment can be made to compensate for any lost motion that develops after the bearings have been placed in service. In order to adjust for end play in the spindle, the method of procedure is to raise or lower the spindle until nuts *A* appear in the opening of the frame. The lower nut is used for making the adjustment, after which the upper one is firmly screwed down to lock the adjusting nut in place. Side play of the spindle is taken up by first loosening nut *B* at the lower end of the spindle and then tightening the spindle sleeve by screwing down nut *C*.

Mounting for Ball Bearings Carrying Vertical Spindles

Where ball bearings are employed to support a vertical spindle, special means must be provided to prevent the escape of oil from the bearing mounting. An example of this kind is shown in Fig. 21, which illustrates the design of Gurney ball bearing mountings for the vertical spindle of a wood shaper. In this illustration we are particularly concerned with the arrangement of the main radial bearing at the upper end of the spindle. Here it will be seen that a threaded collar *A* is provided to clamp the inner race against the shoulder. Secured between the raceway and shoulder on the spindle there is a pressed steel cup *B*, which revolves with the inner race of the bearing. Oil is caught by this cup, and as the spindle rotates at high speed, centrifugal force tends to throw the oil out against the inclined side of the cup, with the result that the oil is projected from this inclined surface up into the bearing. It will be seen that a small amount of space is provided between the under side of the cup and the casting beneath it. Oil finds its way into this space, but its escape is prevented by the fact that rotation of the cup at high speed imparts sufficient motion to the oil so that centrifugal force causes it to work upward through the labyrinth space, thus finding its way back into the oil-cup *B*. Also, the clearance is so small that only a very small amount of oil finds its way into the space below the cup.

Another form of labyrinth seal is shown in Fig. 25. This is known by the Gurney engineers as a "grist-mill" seal, because its action in excluding dirt from the bearing is similar to the action of the old-fashioned stones of the grist mill in ejecting ground flour. Where two horizontal surfaces are rotating in contact with each other, experience has shown that any material finding its way between the two surfaces tends to work toward the outer periphery. It is on this principle that the stones of the grist mill were able to eject flour; and

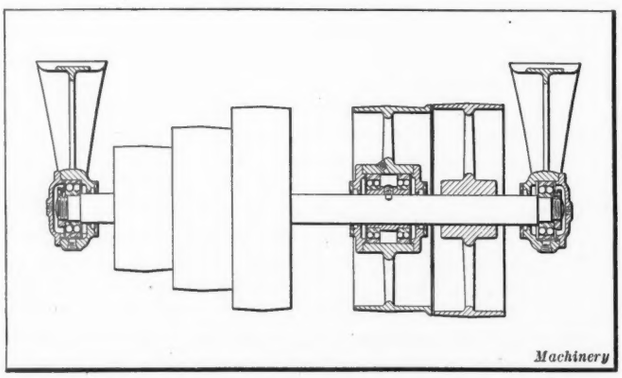


Fig. 26. Self-aligning Radial Ball Bearings supported in "Rigid" Type Shaft Hangers

the bearing seal we now have under consideration ejects dirt and other foreign matter in the same way.

Mention has already been made of the use of spiral grooves cut in a shaft carried by ball bearings in order to provide for the retention of oil in the bearing mounting and the exclusion of dirt and other foreign matter. It will be recalled that two sets of grooves were cut, with the spirals right- and left-hand, respectively, in order to provide for the performance of these two functions. This arrangement of spiral grooves on spindles carried in ball bearings may also be used for another purpose, namely, to provide for the circulation of oil between different bearings. Such an arrangement is shown

in Fig. 22. In this illustration it will be seen that tubes are provided to connect the mountings of bearings at the upper and lower ends of the spindle, in order to allow oil to circulate from one mounting to the other. The arrows indicate the direction in which the oil flows, and the way in which this circulation of lubricant is accomplished will now be briefly described.

Oil contained in the lower bearing mounting descends by gravity into the spiral groove *A*, which is cut at the lower end of the spindle. This spindle runs at high speed, and the oil which flows into the groove is driven up through tube *B* into the mounting of the upper bearing. After circulating through this bearing, where it provides for efficient lubrication and adequate protection of the balls and raceways from rust, the oil finds its way into tube *C*, through which it flows down to the bearing mounting at the lower end of the spindle. At several points in this article mention has been made of the absolute importance of keeping ball bearings perfectly clean in order that they may operate efficiently and be protected from damage. In the present instance a threaded plug *D* is provided, and by removing this plug the oil may be drained out of the bearings, after which the entire system is flushed with kerosene to be sure that all traces of foreign matter have been removed before replacing plug *D* and adding a fresh supply of lubricating oil. In this illustration it will be seen that spiral grooves are provided at each side of the ball bearings in order to provide for excluding dirt. This is the same arrangement which has already been described.

In Fig. 23 there is shown another example of how a spiral groove machined in the surface of a high-speed rotating member may be utilized to afford means of circulating oil between two or more ball bearings. In the present case it will be seen that a sight-feed oil-cup *A* is provided, which is filled with oil to a sufficient height to provide for keeping the lower ball bearing flooded. It will, of course, be evident that from cup *A* the oil circulates through the system of conduits to reach the lower bearing. Machined in the hub of the pulley there is a spiral groove *B*, and as the pulley rotates, this groove causes the oil to work through the conduits so that it eventually finds its way into the upper ball bearing. A pressed steel deflector *C* catches the oil which is thrown from the vertical conduit and guides it down into the bearing. After lubricating the balls and races of the upper bearing, this oil drains down into the lower bearing. It will be evident from

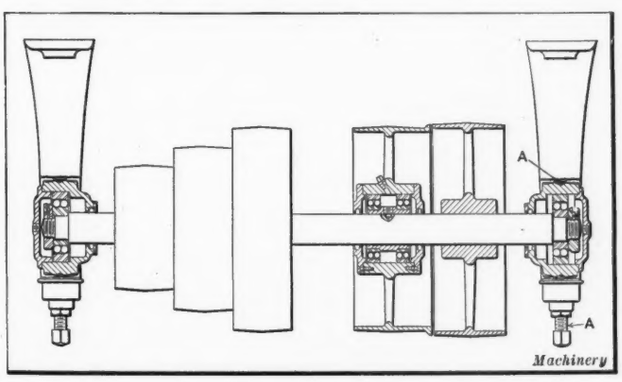


Fig. 27. Same Type of Bearings shown in Fig. 26 mounted in Adjustable Boxes

the illustration that an arrangement of drain plugs is provided to allow used oil to be removed and bearings flushed with kerosene before adding a supply of fresh lubricant.

Fig. 24 shows another design for the bearing mounting illustrated in Fig. 23. The purpose of this construction is to have the inner race secured to the rotating member, and thus secure a slower ball speed than it is possible to obtain where the outer race is fastened to the rotating member and the inner race is a free fit, as shown in Fig. 23. In the mounting shown in Fig. 24, oil flows from cup *A* into spiral groove *B*, from which it is pumped up through the conduit into duct *C* and thence to the upper ball bearing. After lubricating this bearing, the oil drains down to the lower bearing, and then spiral groove *D* assists in carrying it around into groove *B*.

Ball Bearing Countershafts and Lineshaft Hangers

The application of ball bearings in countershafts and lineshaft hangers is the means of making such a substantial saving in power consumption that progressive factory managers cannot afford to overlook this proposition. Investigations which have been made of friction losses in plain bearings have shown that these often amount to 40 per cent of the total power consumed in operating the mechanical equipment of a plant. Through the substitution of ball bearings for plain bearings, 60 per cent of this wasted power can be utilized; in other words, the ball bearings are responsible for saving 24 per cent of the total power required to operate a plant equipped with plain bearings. In the case of countershafts and lineshaft hangers, no argument can be advanced against the use of ball bearings, as a very slight amount of shake is not objectionable, and, when properly mounted, ball bearings are easier to keep lubricated than plain bearings.

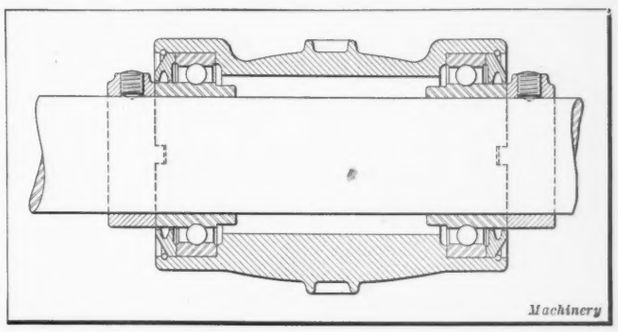


Fig. 28. Cross-sectional View of Ball Bearing Hanger Box which can be substituted for a Plain Bearing Box

In Fig. 26 there is shown what is known as a rigid type of hanger equipped with S K F double-row radial ball bearings. A hanger of this type is not generally used on ball bearing countershafts, but owing to the self-aligning feature of the S K F bearing, all difficulty which might be experienced through inaccuracy in alignment of the shaft is overcome. Fig. 27 shows the conventional type of hanger for use in cases where ball bearings are employed. Here it will be seen that the ball bearings are contained in a box that is supported by means of screws *A* that engage pockets machined in the outside of the box for that purpose. By regulating the position of screws *A*, the box containing the bearing can be raised or lowered, or adjusted sidewise, in order to accurately align the bearing with the shaft and thus relieve it of all unnecessary strain.

Double bearing hanger boxes of the type made by the Fafnir Bearing Co., New Britain, Conn., are adapted to fit any standard hanger frame. Accordingly, it is a simple matter to substitute them for any type of standard hanger box, since this operation does not involve taking down hanger frames. An examination of the accompanying cross-sectional view, Fig. 28, will show the advantages of this type of hanger box. To begin with, the simplicity and ease with which the box can be installed or removed is too apparent to require further elucidation. Furthermore, through the use of two bearings, the load is distributed between two supports, effectively eliminating all possibility of cramping the bearings as a result of shaft misalignment. Finally, though each box can be mounted between thrust collars if deemed advisable, it is usually sufficient to mount a single box (preferably in the center of the line) between collars, resulting in all end thrust loads being carried by ball bearings and in adequately stabilizing the shaft against end play.

In comparison with plain bearings, the application of ball bearings to countershafts results in a pronounced economy in power and oil, and greatly facilitates cleanliness. Moreover, the wear and tear on the belts is much less, and in many instances lighter or narrower belts will suffice. When belts are shifted, the ball bearing installation assists in picking up speed. Finally, since slippage is lessened, wear is correspondingly reduced. Fig. 29 shows a countershaft fitted with ball bearings which is made by the Rivett Lathe & Grinder Co., Brighton, Boston, Mass., for use in driving grinding machines

built by this firm. In addition to the generally accepted advantages of ball bearings, it is found that the particular type of grinding machine driven by this countershaft demands a wide variation in spindle and countershaft speeds; for instance, the headstock or work-spindle is driven at a comparatively slow speed, the reciprocating mechanism for the table is driven at a higher speed, the pump for the coolant is driven at a still higher speed, while the grinding-wheel spindle requires a very high speed. By using ball bearings for pulleys and shafts, it has been found possible to have an idler pulley run on a shaft which is revolving in a direction opposite to that of the pulley. By taking advantage of this condition, the number of shafts in the countershaft can be reduced from four to two, making a much neater and easier running outfit.

Application of Ball Bearings in Electric Motors

The source of power that provides for driving an expensive machine tool or a group of tools should be carefully guarded against the necessity of shutting it down during working hours. Where such a shut-down becomes necessary, it means that one or more expensive machines and the operators of these machines are kept idle, with the result that there is a serious stoppage of production and loss of manufacturing profits. Take the case of motors used to supply power machinery by either the individual or group system of driving. If a bearing in one of these motors becomes heated, or if the motor fails

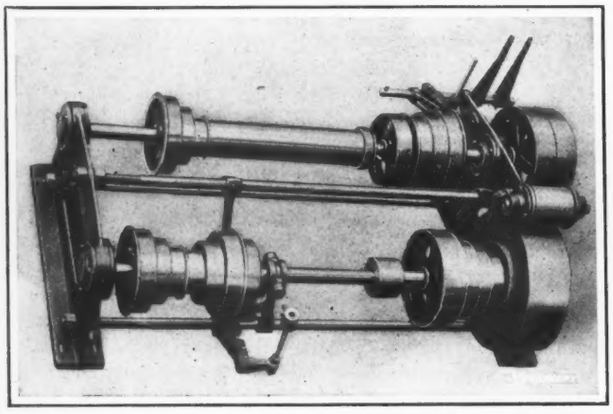


Fig. 29. Ball Bearing Countershaft of Type built to drive Precision Grinding Machine

to operate properly because of wear in the bearings, it means that the machine or machines driven by the motor are forced to remain idle while the motor is being repaired. When applied to electric motor service, ball bearings permanently preserve the correct alignment of the armature shaft and virtually eliminate wear, making practicable the maintenance of a minute air-gap without danger that the armature will ever drop and strike the pole pieces. In this manner, the magnetic leakage is reduced to a minimum and the efficiency of the motor is correspondingly increased. In addition to this, ball bearings occupy much less space than plain bearings, save oil, permit higher speeds, and conserve a large amount of energy which otherwise would inevitably be consumed in friction. Also, the bearings of electric motors are subject to the same general classes of trouble which are experienced with plain bearings used in other classes of equipment.

Substitution of Ball Bearings for Plain Bearings

In substituting ball bearings for plain bearings, judgment must be used in other ways besides deciding upon the particular size and type of bearing which is suitable to meet the requirements of service under which the bearing is to be used. A change from the use of plain bearings to ball bearings may introduce certain complications which call for the provision of special means of overcoming them. A case in point is seen where the armature spindle of an electric motor is to be supported by ball bearings instead of plain bearings which were formerly employed. The theoretical point contact between the balls and races of a ball bearing is the means of greatly reducing frictional resistance of the bearings, but this benefit is secured at the expense of less support for the shaft to assist it in resisting the tendency to bend under the load which it is called upon to carry. If an armature spindle is not accurately balanced, it may be that this decreased support of the shaft against bending, which results from the substitution of ball bearings for plain bearings, will be responsible for the development of an excessive amount of vibration or trouble from some other cause. The obvious way to guard effectually against such conditions is to employ a stiffer spindle. This is an entirely logical course of procedure, because if a ball bearing offers less resistance against bending of the shaft, the shaft must naturally be larger and stiffer in order to support the load. In many cases where ball bearings are substituted for plain bearings to support a motor armature spindle, it is found that the desired resistance against bending may be obtained by simply increasing the diameter of the shaft between the ball bearings, having the bearings abut against a shoulder at each end of the enlarged central portion of the shaft, so that it is unnecessary to change the design of pulleys, gears, or other details which assemble onto the shaft.

* * *

SPECIFICATIONS FOR CAST IRON FOR AIRCRAFT

The International Aircraft Standards Board, working under the direction of the Bureau of Standards, Department of Commerce, Washington, D. C., has issued specifications for cast-iron airplane parts, this material being suitable for piston rings, cylinder liners, valve guide bushings, etc. The following chemical composition is desirable:

	Per Cent
Total carbon, minimum	2.80
Combined carbon, maximum	0.75
Manganese, maximum	0.75
Phosphorus, maximum	1.00
Sulphur, maximum	0.12
Silicon, maximum	2.25

The manufacturer must subject each piston ring to a springing test; only rings may be submitted to the inspector that have been pressed over a cone until the distance between the ends of the ring is equal to seven and one-half times the mean thickness of the ring; upon removal from the cone, the ring must show no set. At least 25 per cent of the piston rings submitted at any one time shall be subjected to the springing test.

A test bar supported on knife-edges 12 inches apart and loaded centrally by means of a knife-edge must show a minimum breaking strength of 400 pounds and a minimum deflection of 0.15 inch under a load of 350 pounds. The test bars must have a Brinell hardness number of 200 to 240 and a Shore scleroscope hardness number of 33 to 40. The hardness tests may also be made on castings selected at random, which must conform to the requirements specified.

For all castings, test bars shall be cast of the same metal and under the same conditions as the castings they represent. The test bars shall be 0.5 inch square and 14 inches long, and shall have identification marks, such as a serial number and date, cast on them. One test bar shall be required for each lot of 250 castings or less. Samples for chemical analysis shall be taken from the test bars, but may also be taken from any casting chosen at random. In the case of piston rings, the samples shall be taken from the rings.

* * *

THE STORING OF COAL

Recently completed experiments and tests begun in 1910 under the direction of Professor S. W. Parr at the Engineering Experiment Station of the University of Illinois show that, if properly sized and carefully handled, coal may be stored without danger of spontaneous combustion; that the actual loss of heat value, or deterioration, resulting from storage is slight; and that underwater storage eliminates entirely all risk of spontaneous combustion or of deterioration. It is estimated that the lack of storage facilities necessitates a capital investment in mines and railroad cars of $500,000,000 in excess of the amount that would be required if production and transportation could be maintained at a uniform rate throughout the year.

CRITICAL SPEED IN TAPERED SHAFT DESIGN

DERIVATION OF FORMULAS AND EXAMPLES ILLUSTRATING THEIR USE

BY ALFRED MUSSO[1]

When the speed of a shaft is increased beyond a certain limit, the shaft will suddenly start to vibrate violently and whirl into the form of a bow with a node at each bearing. A further increase of speed will cause the shaft to return to its rigidity and true line until a still higher speed is reached, when the shaft suddenly begins to vibrate again and whirls into the form of two bows, there being three nodes, one at each bearing and one in the middle. A further increase of speed will again restore the shaft to its line and rigidity, while a still higher speed will cause it to whirl into three bows, and so on. In each case the whirling occurs at a certain speed for each shaft; these speeds are known as critical speeds and are referred to as the first, second, third, etc., critical speed of the shaft.

The whirling of a shaft driven at a critical speed is a vibratory phenomenon by which the elastic forces of the material of which the shaft is made are neutralized and the resistance of the shaft becomes impaired. If after the critical speed is reached this particular speed is maintained, the bending of the shaft will continue to increase until the elastic limit of the material is surpassed; then deformation sets in permanently and the shaft ultimately collapses. For these reasons, the importance of the critical speed of a shaft cannot be overestimated in machinery design. For all purposes of safety, the first critical speed should never be attained, and ordinary practice requires that the highest speed at which a shaft is to be driven shall not exceed 80 per cent of its first critical speed.

The value of the first critical speed of a horizontal tapered shaft freely supported at the bearings, with a concentrated load at the center shaft, is given by the fundamental formula:

$$N = \frac{187.7}{\sqrt{\delta}} \qquad (1)$$

where N = critical speed, in revolutions per minute; and
δ = static deflection of shaft.

In the accompanying illustration, let AB represent a shaft with the central part C parallel and its ends tapered as shown. Call its length L, its largest diameter D, its smallest diameter d, and the central load W. Then the maximum bending moment caused by such a load is $\frac{WL}{4}$ and the bending moment diagram will be represented by the triangle EFG. From the theory of the deflection of beams it is known that the maximum deflection is the area of one-half the bending moment diagram multiplied by the distance of its center of gravity from the support, and this product divided by the product of the elastic modulus of the material of which the beam is made and the moment of inertia of the section of the beam. Considering the shaft as a simple beam, and neglecting weight, let:

δ = static deflection;
a = distance of center of gravity of one-half bending moment diagram from left support;
E = elastic modulus;
I = moment of inertia of section;
D_1 = diameter distant a from left support.

Then:

$$\delta = \frac{\text{area } EFH \times a}{EI} \qquad (2)$$

But area $EFH = \frac{WL}{4} \times \frac{L}{4} = \frac{WL^2}{16}$, and $a = \frac{L}{3}$; then:

$$\delta = \frac{WL^3}{48EI} \qquad (3)$$

where $I = \frac{\pi}{64} D_1^4$. Calling the taper angle α,

$$D_1 = d + 2a \tan \alpha \qquad (4)$$

[1]Address: 197 N. 19th St., East Orange, N. J.

but $\tan \alpha = \frac{D-d}{L-C}$; so

$$D_1 = d + \frac{2L}{3}\left(\frac{D-d}{L-C}\right) \qquad (5)$$

From Formulas (3) and (5):

$$\delta = \frac{64WL^3}{48\pi E\left[d + \frac{2L}{3}\left(\frac{D-d}{L-C}\right)\right]^4} \qquad (6)$$

The value of the maximum static deflection as given by Formula (6) may be substituted in Formula (1), and thus the value of the critical speed for the shaft under investigation obtained.

Solution of Most Common Problem

The most common case that occurs to the designer is the inverse of the one already treated, because the working speed of the machinery under project is generally known, while the dimensions of the shaft are looked for. In this case the proceeding may be embodied in the three following rules:

Rule 1—To find the highest safe value for the static deflection, substitute the given maximum working speed of the machine plus 20 per cent for N in Formula (1), and solve for δ; thus, calling V the working speed,

$$\delta = \left(\frac{187.7}{1.2V}\right)^2 = \frac{24{,}467}{V^2} \qquad (7)$$

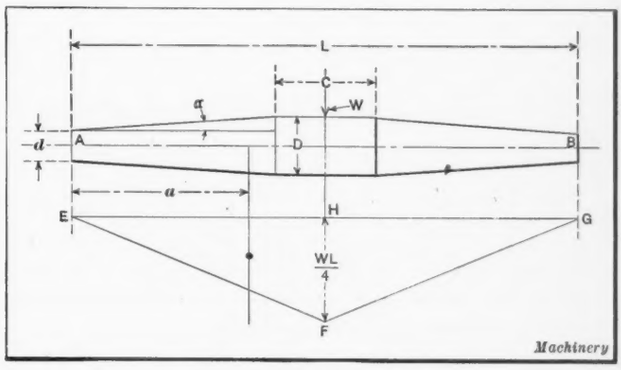


Diagram for determining Critical Speed of Tapered Shaft

Rule 2—To find the diameter D_1 of the shaft at a point one-third its length from a bearing, substitute in Formula (3) the value of δ obtained by Formula (7) and solve for I; multiply the value thus found by 20.37 and extract the fourth root of the product. As $I = \frac{\pi}{64} D_1^4$, $D_1^4 = I \times \frac{64}{\pi} = 20.37I$. Also, as $\delta = \frac{WL^3}{48EI}$, by substituting the value just found for δ, we get:

$$I = \frac{WL^3V^2}{1{,}174{,}368E}; \text{ and } D_1^4 = \frac{20.37WL^3V^2}{1{,}174{,}368E} = \frac{WL^3V^2}{57{,}651.8E}$$

and

$$D_1 = \frac{\sqrt{VL}}{15.49}\left(\sqrt[4]{\frac{WL}{E}}\right) \qquad (8)$$

Rule 3—To obtain the taper of the shaft and, ultimately, the maximum diameter of the shaft, substitute in Formula (4) the value of D_1 obtained by Formula (8); establish safe values for $\tan \alpha$ and C consistent with the general design of the machine and solve for the value of $\tan \alpha$.

Thus, if $\frac{\sqrt{VL}}{15.49}\left(\sqrt[4]{\frac{WL}{E}}\right) = d + 2a \tan \alpha$,

$$\tan \alpha = \frac{1}{10.33} \times \frac{\sqrt{V}}{L}\left(\sqrt[4]{\frac{WL}{E}}\right) - d \qquad (9)$$

and the maximum diameter is found to be:

$$D = d + (L - C) \tan \alpha \qquad (10)$$

Example 1—Find the maximum safe speed for a shaft freely supported that is parallel for a length of 14 inches in the middle and has a straight taper toward each end. The total

length of the shaft between supports is 108 inches; the maximum diameter is 10 inches; the minimum diameter is 7 inches; the central load, 17,920 pounds; and the elastic modulus of steel, 26,880,000 pounds per inch. In other words, $L = 108$ inches, $D = 10$ inches, $d = 7$ inches, $C = 14$ inches, $W = 17{,}920$ pounds, $\tan \alpha = \frac{3}{94}$, $A = \frac{L}{3} = 36$ inches, and $E = 26{,}880{,}000$ pounds per inch. Then, by Formula (5):

$$D_1 = 7 + \frac{2 \times 36 \times 3}{94} = 9.29 \text{ inches}$$

By Formula (6):

$$\delta = \frac{64 \times 17{,}920 \times 108^3}{48 \times 3.14 \times 26{,}880{,}000 \times 9.29^4} = 0.048 \text{ inch}$$

and, finally, by Formula (1):

$$N = \frac{187.7}{\sqrt{0.048}} = 856.6 \text{ revolutions per minute}$$

which is the critical speed. The safe speed will be 80 per cent of this, or 684 revolutions per minute.

Example 2—Design a shaft with a centrally loaded rotor weighing 10,000 pounds, fastened to a collar shrunk on the shaft. The length of the collar is 12 inches; the length of the shaft between supports is 120 inches; the diameter at the bearings is 6 inches; the working speed of the machine is 900 revolutions per minute. The shaft is made of high-carbon steel having an elastic modulus of 29,000,000 pounds per inch.

By Rule 1, the critical speed of the shaft is found to be $900 + (900 \times 0.20) = 1080$ revolutions per minute. Substituting this value in Formula (1) gives $1080 = \frac{187.7}{\sqrt{\delta}}$; solving for δ gives $\delta = \left(\frac{187.7}{1080}\right)^2 = 0.0302$ inch as the static deflection of the shaft. By Rule 2, the moment of inertia is:

$$I = \frac{10{,}000 \times 120^3}{48 \times 29{,}000{,}000 \times 0.0302} = 411 \text{ inches}$$

and $D_1^4 = \frac{411 \times 64}{3.14} = 8377$, from which the diameter of the shaft, 40 inches from the bearing, is found to be $D_1 = \sqrt[4]{8377} = 9.56$ inches. Substituting the known values in Formula (5) gives:

$$9.56 = 6 + \frac{2 \times 120}{3}\left(\frac{D-6}{180}\right) = 6 + 0.74D - 4.45$$

and solving this for D gives as the maximum diameter of the shaft:

$$D = \frac{9.56 + 4.45 - 6}{0.74} = 10.8 \text{ inches}$$

From the data thus obtained it is easy to lay out the outline of the shaft.

* * *

COOLING LUBRICANT FOR SCREW MACHINE WORK

BY M. C. HOBART[1]

Generally, the cooling lubricants used for automatic screw machines are animal lard oil, mineral lard oil, a mixture of one of these with either kerosene or a paraffin oil, or an oil or paste that is soluble in water. The use of either a straight animal or mineral lard oil for screw machine work is practically prohibited today because of the price of these materials. Many manufacturers object to the use of a water compound on their machines, because of the action of the water on the bearings, slides, and tools, and use a mineral lard oil cut with kerosene. The kerosene is not used, however, as some salesmen recommend, simply to cut the cost of the coolant, but to obtain sufficient fluidity to enable the oil to reach the point of the tool in the deep drilling and reaming operations. However, the kerosene has no lubricating value nor any special cooling property, but cuts the lubricating oil out of the bearings and greatly increases the amount of repair work necessary.

These were the conditions a year ago in the factory with which the writer is connected, and which have been met successfully. Since February, 1917, in a battery of Cleveland automatics, an asphaltic base machine oil of a good grade and a fairly high viscosity has been used. This oil has a specific gravity of 0.93, or 20½ degrees Baumé. When the proposal to try such an oil was made, we were skeptical, but tested it on the hardest job in the shop, which was a double bevel gear blank turned out of 2-inch cold-rolled steel. In addition to removing considerable metal with overhang and forming tools, a 5/8-inch hole had to be drilled and reamed 4 inches in depth. The mineral lard oil mixture would not reach the tool point continuously on the latter operations and the tools had to be constantly reground. As a result of comparative tests of the mineral lard oil cut with kerosene, and the asphaltic base oil, we signed a contract for a year's supply at a price per gallon just one-half that of the mineral lard oil.

Early this year another test of the asphaltic base oil was made on the same machine and the same piece as before; this showed that we were obtaining the same quality of oil, as the test was even more favorable than the previous one. The results of these tests are given in the accompanying table. In addition, we have had less trouble with breakdowns and the machines are in better condition today than ever, as regards the results of lubrication, while production has been materially speeded up. The same oil is being used in the lubrication of the lineshafting and machine tools, thus doing away with the necessity of keeping more than one kind of oil in storage. In view of the greater quantity of this oil consumed in a year, due to the combined uses, a better price is obtained on the annual contract.

Why Lubricating Oil is Successful for Cooling

The question has been raised as to why an oil that is primarily a lubricating oil should be so successful as a coolant. This success is due to several factors, the first of which is the fluidity of the oil. It flows more readily than lard oil and easily reaches the tool point without being cut with some light oil that has no lubricating or cooling value. Lard oil tends to break down or withdraw under heat. A hot chip, up to a certain degree, is essential to the proper cutting action of a tool, but this hot chip will prevent lard oil from reaching the point of contact so that the heat will become too intense and the tool will burn. This is especially true on a deep drilling or reaming operation. The characteristic quality of the southwestern crude stocks from which the particular asphaltic base oil in question comes, as applied to cutting service, is its tendency not to decompose under the heat generated at the cutting tool. In the third place, the great pressure on the nose of a cutting tool tends to curl the chip away; it is, therefore, desirable to have a liquid at this point that is both a lubricant and a coolant.

The specific heat of this oil is between 0.4 and 0.5, which, though not quite so high as that of straight lard oil, is relatively high. This heat-carrying capacity, together with other advantages enumerated, makes the oil superior to any other cutting oil we have tried, and, in addition, its cost is much lower.

[1]Address: 1847 S. Sawyer Ave., Chicago, Ill.

RESULTS OF TESTS WITH ASPHALTIC BASE OIL

Oil Tested	Date of Test	Duration of Test, Hours	Time Lost in Tool Grinding, Hours	Time Lost in Tool Grinding, Per Cent	Number of Pieces Made	Gallons of Oil Consumed	Number of Pieces Made per Gallon
Mixture of mineral lard oil and kerosene.....	Jan., 1917	144	10.50	7.20	485	10.30	47
Asphaltic base oil.....	Feb., 1917	144	4.00	2.80	507	11.25	45
Asphaltic base oil.....	Feb., 1918	30	0.25	0.83	245	4.00	61

Machinery

LETTERS ON PRACTICAL SUBJECTS

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SPLINE GAGES

The use of shafts splined with four or more splines of the general type shown in Fig. 1 has become quite common in the manufacture of automobiles and airplane motors. The close limits shown in Fig. 1 are often required, and gages for this class of work have to be of unusual accuracy. Fig. 2 shows a design of gage which was first suggested for this work. This

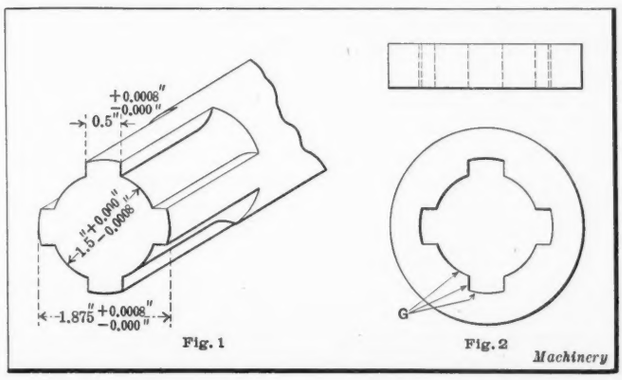


Fig. 1. Splined Shaft for which Gages were designed

Fig. 2. Spline Gage that proved Unsatisfactory

consists of a solid one-piece ring of hardened steel ground all over, but, as will be seen by referring to the illustration, the inside surfaces of the gage could not possibly be ground in the usual way; therefore, the only method of finishing them would be by lapping, and as this would be very expensive and does not insure the required accuracy, the design was rejected.

To overcome this difficulty, a built-up gage was designed as shown in Fig. 3. The body *A* is made of machine steel, carburized, ground, and lapped on the surfaces that form a seat for the segments *B* and *C*. Segments *B* and *C* are made from hardened tool steel and are ground and lapped to the required

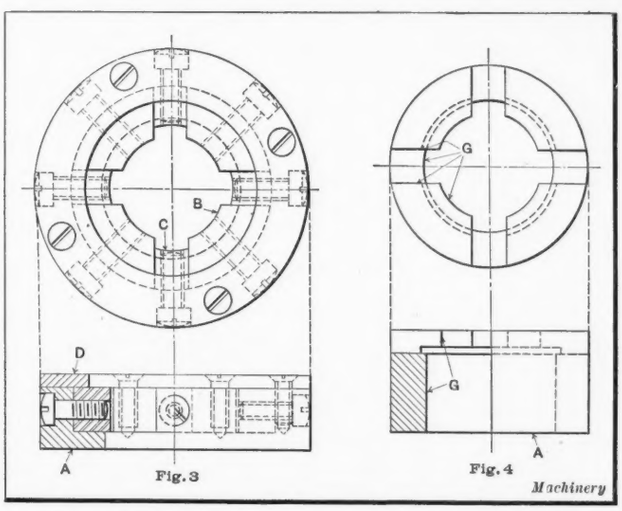


Fig. 3. Built-up Gage for Splined Shaft

Fig. 4. Accepted Design of Gage for Splined Shaft

size. They are held in place by the cover plate *D*. Although this gage can be made to within a limit of accuracy of ± 0.00005 inch, it was not entirely satisfactory.

In Fig. 4 is shown a design of gage that was accepted as being the most satisfactory type for this class of work and the least expensive to make. The gage is made of a single piece of machine steel, pack-hardened, and ground to size. The making of this gage is so simple that any toolmaker can devise his own methods of grinding and finishing. The difficulties that would attend the use of the first two gages will be apparent, especially if the work were held to close limits. As a matter of fact, there would have to be about 0.0005 inch clearance before one could get the gage on, as it would be very difficult to start it square on the work. Unlike the plug and ring gage, which can be given a good coat of oil and then quickly wrung together, this gage, on account of the splines, cannot be given a twisting or wringing motion which would make the operation comparatively easy. The parts must be perfectly square while pushing the gage on.

With the gage shown in Fig. 4, however, it is an easy matter to utilize the wringing motion referred to in starting the gage on the work, because the work enters what is practically a plain ring gage at the end *A*, and it is not until it is fully entered at this end that it is pushed forward far enough to come against the projecting parts which actually gage the splines. As these are then held in perfect alignment with the body of the gage, which is steadied by the work, it is an easy matter to guide them into the splines that they are intended to gage.

New York City — DONALD A. BAKER

DRAFTING-ROOM LABOR-SAVING DEVICES

The drafting-room is not usually considered a good place for the introduction of labor-saving devices; still there are some that, if installed, will effect a saving in time and ma-

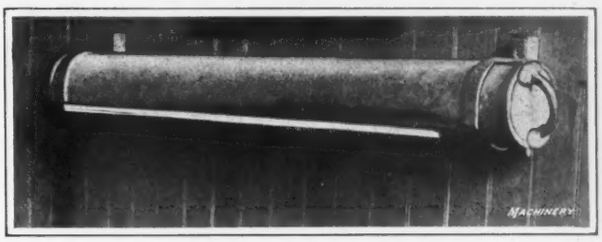


Fig. 1. Handy Holder for Blueprint Paper

terial, besides improving the results. One of these, shown in Figs. 1 and 2, is a sheet-metal tube that is fastened to the wall for the storing of blueprint paper. The paper is passed through a slot which runs the entire length of this tube and is covered by an apron *A*, having a sharp edge. After the desired length of paper is drawn out, a sharp upward and outward pull cuts it from the roll along the edge of the apron. For convenience in measuring, marks may be placed on the wall to show when various lengths of paper, say 18, 24, and 36 inches, have been drawn from the tube. This apron cuts the paper on a straight line square with the ends, thus saving the paper, as it does away with trimming when printing sheets as long as the width of the roller.

A drying rack made of two parallel strips of wood a few inches farther apart than the widest print that will be made can be cheaply constructed; and the prints will be dried in a flatter condition than when they are hung on strings, as in many drafting-rooms. As shown in Fig. 3, the strips are notched on top to take a piece of No. 10 spring wire, on which two ordinary spring clothespins have been threaded. Right-angle bends at each end prevent the pins from slipping off

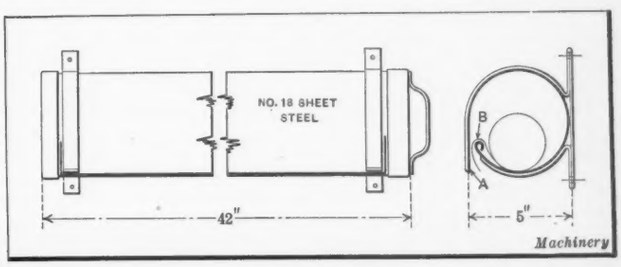


Fig. 2. Detail View of Holder for Blueprint Paper

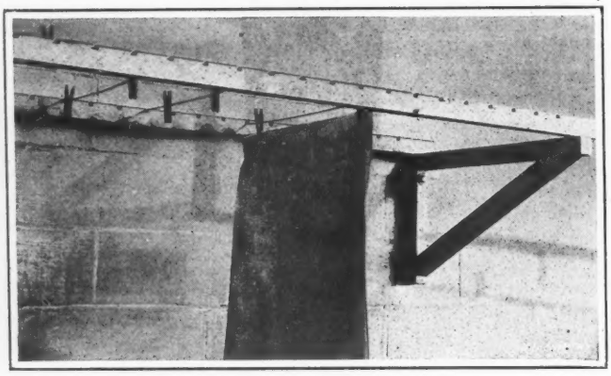


Fig. 3. Rack for drying Blueprints

the wire and getting lost. To use this rack, it is only necessary to take a pin in each hand, pinch them over the print as it lies in the water, and lift the whole thing up to the rack, placing the wire in the notches.

St. Paul, Minn. F. T. HARDING

TESTING SPRINKLER HEADS FOR LEAKS

Automatic sprinkler heads are tested for leaks by forcing water into them under a high pressure. The arrangement shown in the accompanying illustration has been found very satisfactory. The water for the test is stored in a tin-lined wooden tank *A*, placed beneath a tin-lined wooden drip-pan *B*, across the edges of which cross-bars *C* are placed. These cross-bars support the arrangement for holding and testing the heads. In the case shown, this consists of four 1½-inch, five-hole steam-pipe manifolds *D*, separated from one another by 1½-inch globe valves *E*. The end of the last manifold is closed by a petcock *F*, by which the entire system may be drained when desired. It is well, however, to use manifolds having more than five holes, as it increases the number of heads that can be tested at one time. By placing valves between the manifolds, as shown, the arrangement can be used when only a few heads are to be tested. The water in the drip-pan *B* flows back into the storage tank *A* through a drain pipe.

Water is forced into the manifolds by a pump *G*, which draws the water from the tank *A* through a pipe *H*. This pipe should have a check-valve to prevent the water from draining out when the pump is shut down; this will make it unnecessary to prime the pump each time it is to be used. There should also be a globe valve *E* between the pump and the first manifold. Between the pump and the first globe valve, an air chamber *K*, pressure gage *L*, and safety valve *M* should be installed. The air chamber *K* may be made by placing a cap on each end of a piece of 5- or 6-inch pipe and placing on the top cap a petcock *N*. If an air chamber is not used, the water will not flow in a steady stream, but will surge forward with each stroke of the pump piston. The petcock *N* permits the removal of air from the chamber whenever necessary, especially when the pump is started. Any regular steam gage may be used to measure the pressure of the water. The safety valve *M* is needed to maintain the water at the pressure desired.

After all the sections have been assembled, reducers made of 1½-inch by ½-inch cast or rod brass are screwed into the holes in the manifolds *D;* a leather or composition washer should be inserted in each reducer. If the ½-inch hole in the reducers is tapped a little over size, it is not necessary to screw the heads in with a wrench, as they can be screwed down on the packing tight enough to keep them from leaking around the thread. When testing, the heads are screwed in the reducers, and the valves *E* are opened so that the water, which is already at the right pressure, enters the pipes. Any water that has accumulated around the seats of sprinkler heads in handling should be blown away by compressed air, the hose for conveying which is kept in a handy place near the machine. After the heads have been tested, the valve *E* nearest to the pump is closed and the small petcock *F* at the end of the manifolds is opened to drain the water from the manifolds.

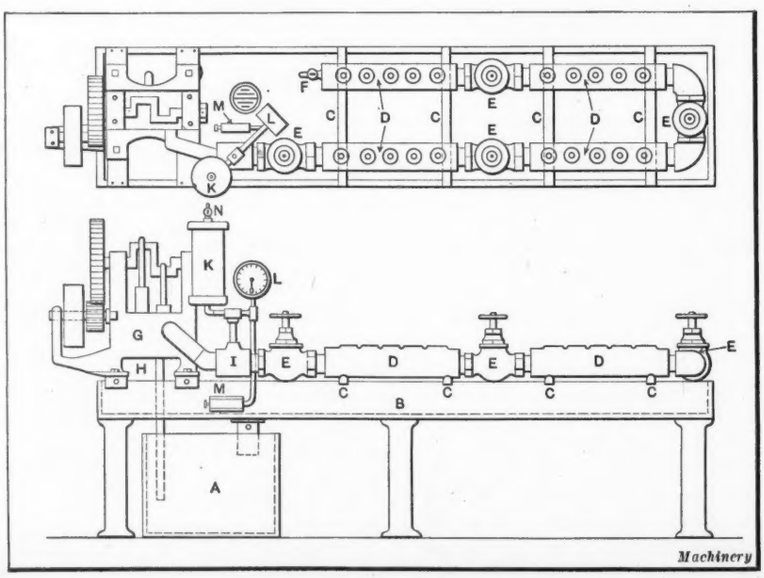
It is good practice to leave the sprinklers that have only a very small leak on the machine for a few testings; this will, nine times out of ten, close them. Sometimes the writer has left heads having slight leaks on the machine for an hour or so, and at the end of that time the greater number of them were all right.

Aurora, Ill. JOHN J. BORKENHAGEN

DESIGNATION OF THREADS

Previous to the war, there were two forms of threads in common use in the United States—the U. S. standard form and the V-thread form—but with the production of war materials in this country, the Whitworth or British standard form has also come into general use in our factories. The two most commonly used standards for the number of threads per inch in the United States are the U. S. and the S. A. E. standards. The S. A. E. is the standard adopted by the Society of Automotive Engineers, and is used almost universally in automobile construction. It has the same form as the U. S. standard thread, but a greater number of threads per inch for the corresponding diameters. The general use at the present time of so many different forms of threads and different standards for the number of threads per inch makes it essential that the drafting-room adopt a standard method of clearly designating the type and number of threads per inch on the drawings.

In adopting standard methods, a simple and fool-proof means must be used. In case a tapped hole is 1/2 inch in diameter and has 13 threads per inch, and the form of thread is the U. S. standard, it is usually designated as "1/2-13 U. S. S. threads." If the hole has 20 threads to the inch, which is the standard number for S. A. E. threads of this diameter, the customary designation is "1/2-20 S. A. E. threads." Sometimes a number of threads per inch that is not standard is used, but the U. S. standard form is retained; then it is shown as "1/2-16 U. S. F. threads" (U. S. F. = United States form). But supposing the draftsman should make an error and show the 20-thread hole as "1/2-20 U. S. S. threads," there would be a contradictory statement between the "20" and the "U. S. S." In cases of this nature the drawing should be returned to the drafting-room for correction. A shop having a contract with another firm found this mistake in the contract drawing. The holes were tapped with 13 threads per inch, regardless of the designated "1/2-20 U. S. S. threads" shown on the drawing. When the concern sued for damages, because they were not tapped with 20 threads per inch, a court in New York state decreed that both parties had made an error and the damages were divided evenly. The party submitting the drawings made an error in designating the thread as "1/2-20 U. S. S. threads,"



Device for testing Sprinkler Heads for Leaks

when the proper designation should have been "1/2-20 S. A. E. threads." The party having the contract made the mistake of doing the work when the drawing was contradictory in its specifications, without sending the drawing back to the company for correction. It is better to eliminate this possibility of error, as well as the time required to find what thread is required, by properly designating the thread desired when making the drawing.

In cases where the U. S. standard number of threads is desired with the V-thread form, it is simply a matter of replacing the U. S. with the letter "V" as, "1/2-13 V-threads"; or if the Whitworth form is desired, as "1/2-13 Whitworth threads." This indicates that special threads are desired, and leaves no doubt as to just what kind of threads are wanted.

Detroit, Mich. CHARLES A. COOK

MILLING DOVETAIL SLOTS ON A LATHE

The cast-iron knife bench shown in Fig. 1 has a dovetail slot cut the full length of one side in which the brass knife carrier slides. This carrier must be a close sliding fit, because the knife cuts woven goods on the loom. As the slot in some of these benches had worn too large in the middle, it became necessary to mill the slot to the larger size throughout its length. Fig. 2 shows the set-up used for doing this on a lathe. The cast-iron knife bench *B* is supported by heavy flat bar clamps *C*, which are secured to the bed of the lathe. To eliminate as much of the vibration as possible, the clamps are fastened to iron braces *D*, the other end of which rests on the floor. Feeler screws *E* in the clamps *C* steady the slender work and at the same time avoid springing the bench *B*. An angle-plate *F* supports the slide *H*, which, instead of carrying the toolpost, has a cast-iron yoke bearing *I* secured to it. This bearing has two brass bushings *L*, which are bored out to fit the taper on the shaft *K*. One end of this shaft has a taper hole for holding the end milling cutter *N*. The other end carries the gear *O*, which is driven by a pinion *P* on the motor shaft. A motor is mounted on a cast-iron plate *Q*, which, in turn, is secured to the top of the carriage; to give stability, two flat braces are attached to the under side of the plate and to the apron, as shown at *R*.

In order to mill the slot, it is only necessary to feed the carriage with the cutter to the end of the work so that the cutter can be started. Then by engaging the lead-screw, the same as for cutting a thread, and throwing in the motor switch, the cutter revolves and is fed along the work at the same time. The first bench milled in this manner was almost spoiled because of the tendency of the cutter to dig in deeper as it approached the middle of the work. It was soon discovered that this was caused by trying to cut the bottom and the side of the slot at the same time. With the next bench, only one side was cut at a time, which eliminated the trouble.

Shelton, Conn. J. LIMBRUNNER

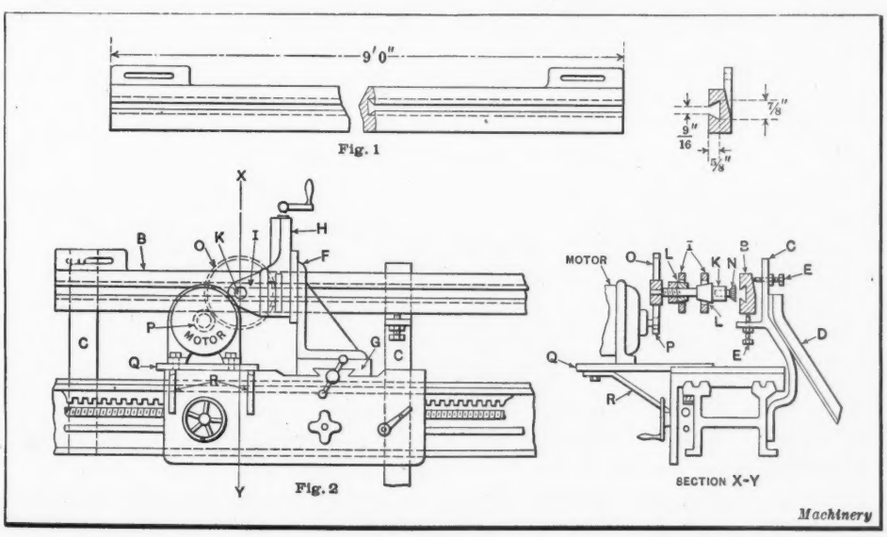
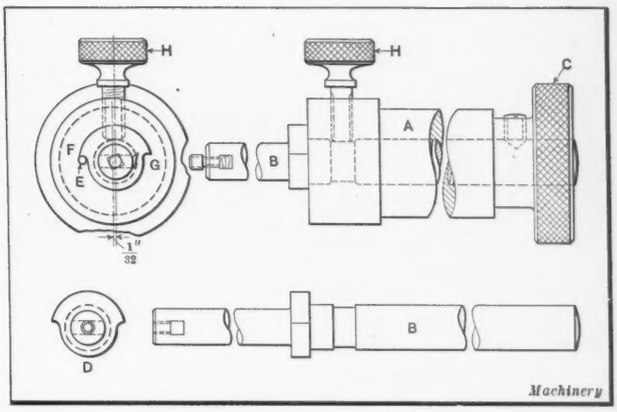


Fig. 1. Cast-iron Knife Bench with Dovetail Slot to be milled. Fig. 2. Set-up for milling Dovetail Slot in Lathe



Recessing Tool for Turret Lathe

RECESSING TOOL FOR USE ON TURRET LATHE

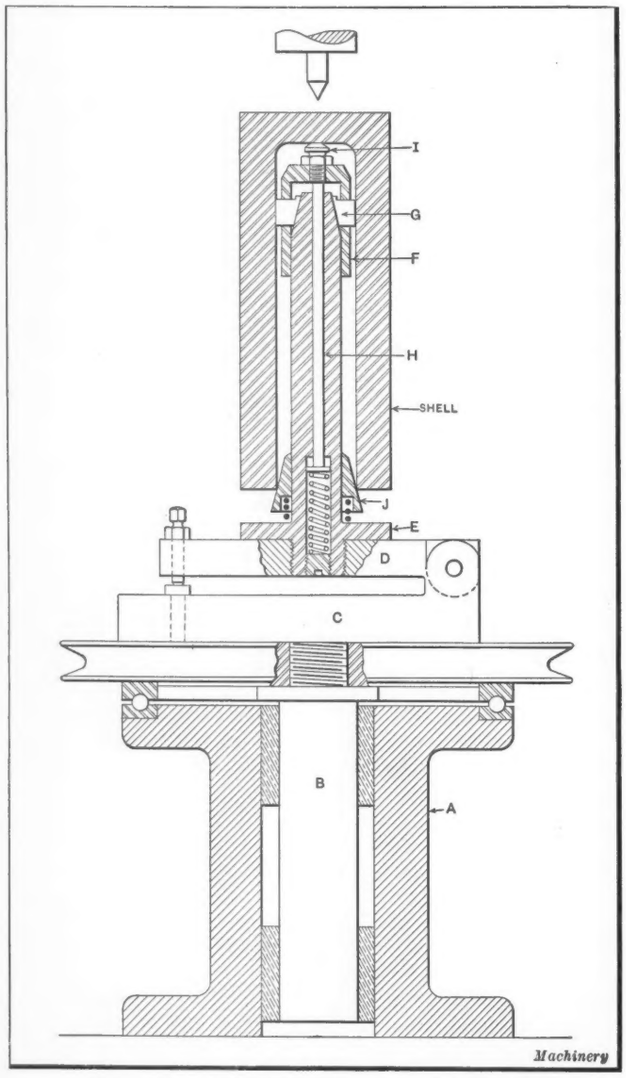
The tool shown in the accompanying illustration was made for recessing 5/8-inch holes in brass sleeves on a turret lathe. It consists of a steel sleeve *A* turned to fit the bore in the turret head. A 5/8-inch hole is bored through this sleeve, 1/32 inch off the center of the collar, to obtain a throw of 1/16 inch. The shank of boring-bar *B* is turned to a running fit in this hole, and is made long enough to leave room for a knurled handle *C*. This handle is fastened on the boring-bar by means of a set-screw, and is removed while setting the tool in the machine. The front end of bar *B* is 1/2 inch in diameter to give clearance for chips. A 3/16- by 3/16-inch tool bit is set to obtain the required size of bore. The collar on the center of bar *B* is milled half way around, as shown at *D*, to form a stop, which engages with a pin *E* and allows the boring-bar to make one-half turn only. In operation, the handle *C* is turned to the left until the cutter reaches point *F*. The cutter is then set to the desired depth in the hole and the handle *C* is turned to the right slowly. When the cutting tool reaches point *G*, set-screw *H* is tightened and the cut can be carried through the required distance. The set-screw is then released and the tool turned back to *F* again, where it can be withdrawn from the bore.

Plainfield, N. J. HENRY DAUT

CENTERING SHELL FORGINGS ON A DRILLING MACHINE

In the manufacture of 4.5-inch high-explosive shells considerable trouble was experienced when boring the inside of the forgings. One source of trouble was traced to the first centering operation, which was accomplished by locating the shell on a spindle that engaged the inside bottom of the shell forging. This method was found satisfactory until some forgings were received that had been pierced by a worn punch of incorrect shape. These forgings had grooved sides, and rough, uneven surfaces at the bottom of the pierced hole, that prevented the locating spindle from centering them properly. Therefore, another centering method was necessary.

As the only machine available was a 16-inch column drilling machine, the table was removed and the arm swung around out of the way. The casting *A* used for the base is bushed to receive a spindle *B*, which is driven by a sheave pulley. The spindle is screwed into the pulley with a left-hand thread, as the direction of rotation is opposite to that of the center drill. Hardened and ground ball races are



Fixture for centering Shell Forgings on Drilling Machine

attached to the sheave pulley and base. The base *C* of the fixture for driving the shell is mounted on the sheave pulley. The hinged plate *D* permits the operator to swing the shell clear of the spindle of the drilling machine. By this arrangement the holder can be let down to a horizontal position, which is more convenient for the operator than the vertical. Into this hinged plate is screwed (right hand) a spindle *E*, the upper end of which is tapered. Three dogs *G*, equally spaced, rest upon this end. These dogs are held in place by a cage *F*, in the slots of which the dogs freely slip in and out. The cage is prevented from coming off the spindle by a grub screw (not shown) riding in a slot in the spindle.

When the shell is placed on the spindle, the open end is located by the taper sleeve *J*, which is held up by spring pressure. The bottom of the hole in the shell comes into contact with a stop-screw *I* and presses down the cage *F*, forcing out the dogs until they come into contact with the wall of the shell. When the shell is removed, the dogs are released by a rod *H*, which is operated by a coil spring. A true machined test shell is kept nearby, so that the machine may be frequently tested to insure accuracy. This device is driven by a half-inch round belt from a small pulley on the clutch shaft, which also carries the lower step cone. Two idlers set at an angle guide the belt.

Medicine Hat, Alberta, Canada JOHN HOMEWOOD

INSERTING THUMB-SCREWS IN WORK ON THE DRILLING MACHINE

Oftentimes in job shops, set-screws, bolts, nuts, keys, taper pins, thumb-screws, etc. are put in small parts before they are sent to the assembling department. The writer was recently given three hundred small parts in which to drill and tap a hole for a No. 10-32 machine screw and then insert a thumb-screw one inch long. The drilling and tapping were done in the usual way, with a geared tapping chuck in one spindle and the tap drill in the other. Fairly good speed was made, as the material was cast iron and there was no oil to bother with. On a previous order of two hundred pieces, it required four hours to insert the screws, as they had to go all the way in, which was very tiring to the operator's wrist.

As the writer was asked to try to reduce the time required for inserting the thumb-screws, he procured a piece of pine, about one inch in diameter, which was a tight fit in the taper hole of the drill spindle; about 1½ inch was left projecting below the end of the spindle. Then running the spindle at its highest speed, the end of the stick was cupped out with a hand tool to fit the curve on the top of the thumb-screw. Placing a box of thumb-screws at his right, a box of the small parts at his left, and an empty box for the assembled parts between his feet, the writer "went to it." After placing a screw in the part and giving it about a turn and a half, he pressed the head of the screw hard against the cupped end of the soft-wood plug in the revolving spindle and practically shot the screw into place. As a result, the screws were inserted in all the parts in less than half an hour, instead of in four or five hours which would have been required if the work had been done by hand.

East Walpole, Mass. J. A. KIRK

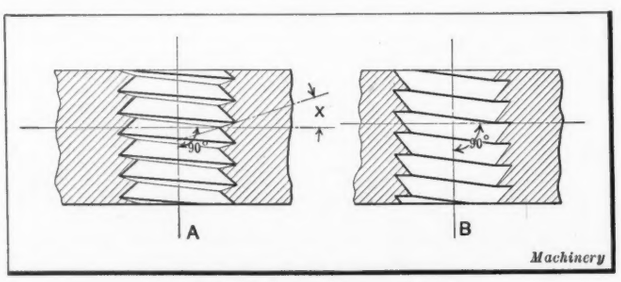
MOTOR BEARING REPAIR

In the case of some direct-drive motors on machines on which the shaft diameter in the bearing was the same as that of the hole in the pulley, the shaft and bushing were cut by reason of lack of oil or by the excessive belt pull. Repairs were effected as follows: In the case of those that were only badly scored, a piece of steel tubing was shrunk over the bearing part of the shaft and turned true, leaving the bearing at this point about ¼ inch larger than the original shaft. The bushing in the motor end was then bored to fit. This gave the advantage of a larger bearing to take the belt pull. Besides, it was possible to use in the pulley end the worn bushing from the commutator end by reboring it to this larger shaft diameter when a second repair was needed. In this way double service was obtained from these bushings and half the work of making new ones was saved, as they only needed to be rebored. Of course, a new bushing was required for the commutator end when it needed repairs, but this end gave little trouble.

Denver, Col. J. L. GARD

BUTTRESS THREADING WITH TAPS

The buttress thread is an unbalanced thread; as shown at *B* in the accompanying illustration, one side is at right angles with the axis and the other at another angle. Hence, the thread has a tendency to creep when tapping or threading with dies. This gives a thread of the form shown at *A*. The imperfect side is always the square side. As buttress threads are used for jacks, vises, and similar work where the pressure is heavy and all in one direction, this poor thread condemns the work entirely, for it presents but a fraction of the full



Imperfect and Perfect Buttress Threads

bearing surface that it should have to give long wearing and easy working qualities to the device. And often the lead is not constant, and the number of threads in an inch is found to be slightly more or less than standard.

Quantities of cast-iron blocks were threaded, as shown at *B* for capstan-head buttress-thread screws. The blocks were tapped in an upright drilling machine with an Errington tapper, but the work was unsatisfactory, because the straight side of the thread was rough and not at a right angle to the axis, as shown at *A*, the straight side forming the angle *X* with the axis; consequently the thread in the blocks did not last long. Different shapes of taps were tried, and different operators employed, but to no avail, although some men could obtain fair results where others failed. The solution offered was the simple one of tapping the pieces from the back and making the taps with the teeth reversed. With this change any workman could obtain a good thread every time as shown at *B*. A similar difficulty was encountered in tapping some steel split nuts that were set loosely in cast-iron bodies. It was imperative that one side of the thread be at right angles with the axis, as any slight divergence from a right angle had a tendency to expand the nut against the light springs that kept it closed. The same method of tapping was employed in this case. Taps made with seven flutes were capable of tapping about two thousand pieces before changing. In this case, a fixture was provided that held the nut securely in the open position while tapping. A lead-screw on the tapping spindle prevented any creeping of the thread either way by being accurately fitted in a thread which was incorporated in the clamping fixture. By the use of the above methods, about six hundred pieces a day of one kind or another are being tapped.

Middletown, N. Y. DONALD A. HAMPSON

BLANKING DIES

Fig. 2 shows a form of die which possesses extraordinary value for experimental purposes, and for use during the preliminary process of establishing an industry and perfecting any appliance or device that is eventually intended for the market. If this type of die is used for all preliminary developments until stability of design is assured, many thousands of dollars may be saved by the manufacturing concerns in this country, as it is a well-known fact that in the development of various kinds of machines, many costly dies constantly go into the scrap pile by reason of slight changes and improvements which are a necessary part of the evolution of such machines.

The cost of making the die shown in Fig. 2 is not more than 15 or 20 per cent of the cost of an ordinary die with guide posts, yet it will do equally as good work where not more than five thousand blanks are to be made from one die. Also work that would require two or three operations with the ordinary form of die can be accomplished in one operation with this type. Work like that shown in Fig. 1 can be produced with this die, and the blanks will have clean smooth edges. Cold-rolled stock may be used for the punch, stripper, and die, and an ordinary filing machine can be used to good advantage in making these dies. This die can be used in any kind of press. It is not bolted down, and ordinary strip stock can be fed through to the stop-pin or peep-hole in the usual way, with the difference that as soon as the punch is driven through the stock into the die, the punch, die, and stock are pulled out together from under the dummy driving

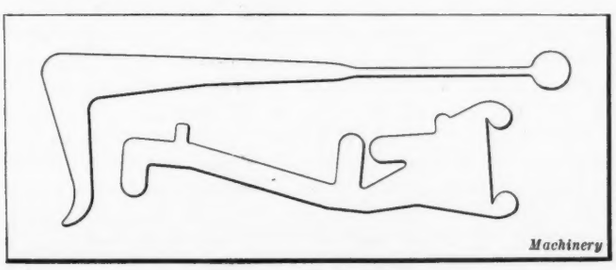


Fig. 1. Die Blank Patterns

punch, the blank and the punch, which is only one-half inch thick, being dropped through into the operator's hand. The stock is then fed through and the operation repeated. The die and punch are both casehardened about twenty or twenty-five thousandths inch deep. This does not materially alter the

INSTRUCTIONS FOR MAKING COLD-ROLLED STEEL BLANKING DIES

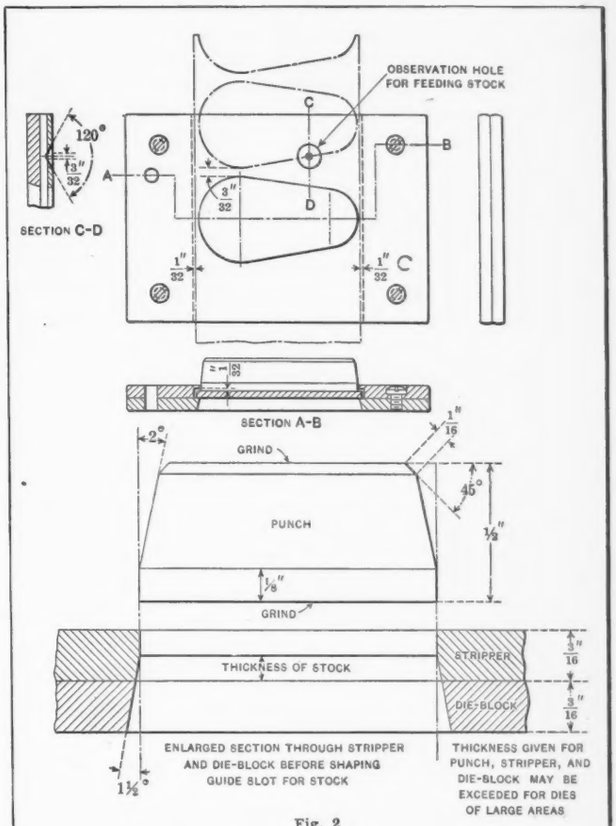


Fig. 2

1. Make templet from 1/16-inch stock. Work to figures; do not scale drawing.
2. Assemble stripper and die-block, using 1/8-inch dowels and 10-32 screws
3. Stamp symbol and tool number on both stripper and die-block.
4. Transfer contour from templet to stripper.
5. Drill and file die opening square through stripper and die-block, fitting opening to templet.
6. File 1½-degree taper in die-block and stripper as follows: Commencing from bottom of die-block, file so that taper extends part way up into stripper measured from parting between stripper and die-block to a distance equal to thickness of stock to be used.
7. File punch square to fit stripper plate opening, fitting opening from bottom up through tapered die-block opening.
8. Remove stripper.
9. Increase diameter of dowel holes to 3/16 inch in die-block *only*.
10. Carburize and harden die-block; straighten after hardening, but do not grind.
11. File 2 degrees taper on punch upward, commencing 1/8 inch from bottom of punch.
12. File 1/16 inch chamfer around top of punch to distinguish it from bottom, and stamp symbol and tool number on top.
13. Carburize punch.
14. Fit punch to die-block, if necessary, to take care of possible distortion in die-block during hardening.
15. Harden punch; stone after hardening in case of distortion to suit die-block opening.
16. Grind punch top and bottom.
17. Align stripper and die-block.
18. Transfer 3/16-inch dowel holes from die-block into stripper.
19. Shape clearance slot in stripper to suit stock—amount of clearance shown on drawing.

Machinery

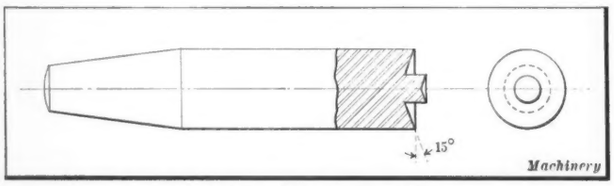
shape of either punch or die, yet they are hard enough for punching out stock up to one-eighth inch thick.

A blueprint similar to that reproduced in Fig. 2 is given the diemaker for making this type of die. The instructions beneath the drawing are typewritten on thin transparent paper and placed over the tracing in the position shown when making the blueprint. In some cases the punch is first finished to the shape of the blank, relieved to within one-eighth inch of the face, which is left parallel, then casehardened, and used to shear through the die. The strip channel is then cut or the stock-pin inserted as the case requires. The die is then casehardened. The foregoing information was secured through the courtesy of George Hoffman, of the Service Machine Corporation, Chicago, Ill.

Chicago, Ill. HENRY H. HARDINGE

EMERGENCY PUNCH FOR MAKING THIN WASHERS

In the accompanying illustration is shown a punch that is very convenient for punching thin washers from sheet metal when a few special washers are needed. The punch can be turned from a piece of round tool steel in a few minutes, and is serviceable for cutting about one hundred washers. It is



Punch for making Thin Washers

suitable for punching sizes up to 1 inch outside diameter, of a thickness up to 3/64 inch, from such materials as brass, bronze, copper, German silver, etc. The punch is used by hand and driven with a hammer into the metal from which the washers are to be made, the sheet metal resting on the end of a block of smooth grained hard wood. The small diameter of the punch cuts the hole, and the large diameter the outside edge of the washer, the two being cut at one stroke.

Brooklyn, N. Y. J. A. WIDMER

BORING AND REAMING BALL BEARING HOUSINGS ON A TURRET LATHE

Two ball bearing housings of different types but of the same size were to be bored and reamed on a turret lathe. Both of these pieces were in the form of a ring with a flat base, but one had lugs on opposite sides, as shown at *B*, Fig. 1. The one shown at *A* could be gripped with a three-jaw chuck on the concentric part, but that shown at *B* had to be held with one jaw on the flat base. The bottom of the tongue was 3/32 inch lower than the radius of the ring, and as this tongue was not finished on the bottom, it could not be built up on the pattern.

It was necessary that false jaws be made for the job, and in order that the two pieces could be held with the same jaws,

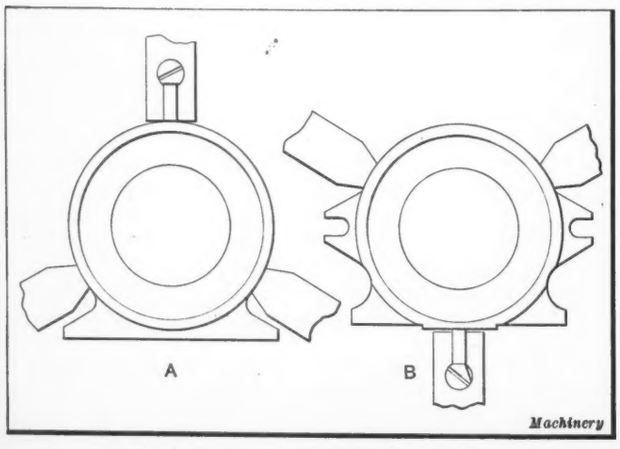


Fig. 1. Two Types of Ball Bearing Housings

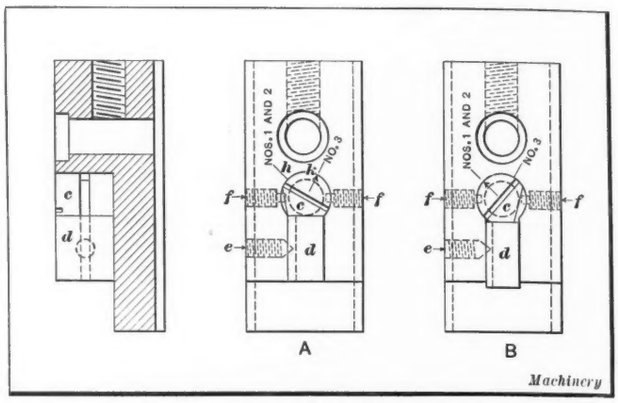


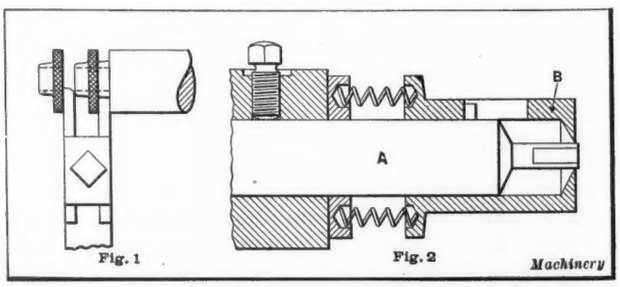
Fig. 2. Chuck Jaw for holding Ball Bearing Housings

and thus save the time of changing, the arrangement shown in the illustration was used. All three jaws were made alike and turned out in the chuck. A 3/4-inch hole was drilled and reamed for the plug *c*, in the jaw shown in Fig. 2, after which a 1/2-inch slot was cut into this hole. The tool-steel plug *c* was then made to fit the 3/4-inch hole with two flat faces, as shown, one of which was 11/32 inch from the center, and the other 1/4 inch. The tool-steel piece *d* was made to fit the slot, its end bearing on the plug *c*, and long enough to come flush with the face of the jaw when bearing on the lowest flat, as shown at *A*. The chuck then held the concentric ring true. By turning the plug so that the end of sliding piece *d* rested on the higher flat, the 3/32 inch difference in height was compensated for by piece *d*, as shown at *B*. A 60-degree slot was cut in the sliding piece *d* to receive the point of a headless set-screw *e* which held piece *d* in place. Also, a 1/8-inch groove was cut around plug *c* and two headless set-screws *f* were put in to keep the plug in place. The plug and jaw were then marked as shown at *h* and *k* to avoid the possibility of mistake. They were then casehardened, and the sliding piece and plug were hardened and tempered.

East Bridgewater, Mass. P. S. THOMAS

SUPPORTING AND EJECTING TOOL FOR AUTOMATIC SCREW MACHINE

When cutting off more than one piece at a time on an automatic screw machine, there is always the risk of the pieces



Figs. 1 and 2. Nuts that are machined on Automatic Screw Machine, and Tool for supporting and ejecting Work after cutting off

between the tools not falling or being pushed out; this means an accident when the next cutting-off operation takes place. The round nuts shown in Fig. 1 are typical examples of this class of work. While the inner one may clear itself for long periods, when it does not there is a broken blade, if nothing more. The tool shown in Fig. 2 was made for use on an automatic screw machine to catch both pieces as they are cut off and hold them in alignment until the cutting-off tools recede, when the nuts are ejected and drop into the chute. It is simply a piece of cold-drawn steel *A*, set in the fourth tool position and having a pilot turned on the end, which enters the drilled bar in time to catch the nuts as they are cut off. The cutting-off tool backs out before the turret moves, leaving the nuts on the pilot against the ejector piece *B*, which has been pushed back by the forward movement, compressing the light springs. The normal extension of these springs ejects the nuts.

Middletown, N. Y. DONALD A. HAMPSON

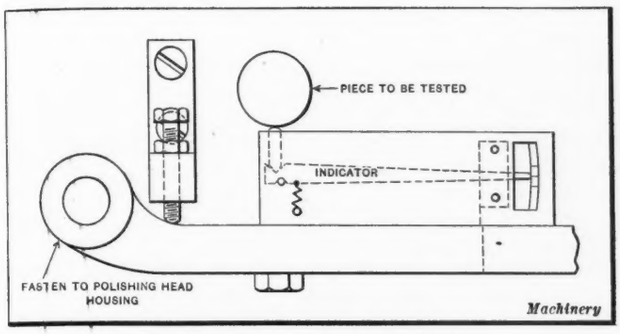


Fig. 1. Indicator for testing Eccentricity

MACHINE ACCURACY IN MANUFACTURING SMALL INTERCHANGEABLE PARTS

In the manufacture of small interchangeable parts that are to be produced in quantities to very accurate manufacturing limits and on which work is performed on both ends, the question of machine alignment is of vital importance. Various devices are employed to help overcome irregularities, such as floating tool-holders, steadyrests, pilot centers, draw-back chucks, and piloted tools. The success of such work depends upon accurate alignment of the machines, and not only the ways, but also the turrets and chucks, must be true. Turret holes can, of course, be bored in place, but the shanks of boring-bars and tool-holders should be tapered.

Automatic and semi-automatic machines present the greatest difficulties inasmuch as they may not be accurate enough when the work must be held to about ± 0.0015 inch limits. These machines are carefully made with jigs, and the alignment is generally obtained from the most accurate spindle; that is, each spindle is indicated with the chucks or tool-head holes, and when the most accurate spindle is found, all the others are aligned with this, but still there is room for inaccuracies which are accentuated beyond the limit of accuracy required when a relatively small amount of wear has taken place.

A spindle will sometimes indicate correctly if the bearing boxes are not tightened, but when work is being done, it is, of course, necessary to have the bearings tightened and they may not then line up with each other. If the tool-heads had tapered shanks to fit tapered sockets in the spindle, there would be less variation, but ordinarily they are not tapered, so that when the set-screws are tightened, the tool-heads are forced out of alignment. A convenient method of checking the accuracy of work is to place the part on a mandrel, rotate it, and indicate the opposite end. If the spindle, chuck, or tool-holders are out of alignment, the amount of eccentricity is easily measured. It is better to do this periodically, and as wear occurs the machines needing the most attention can be watched and checked more often by the inspectors. A convenient indicator is shown in Fig. 1. The construction is very simple, and the one shown was fastened to a small polishing head.

In machining work like a fuse body, it is necessary to work from both ends, which must be concentric. To accomplish this, the spindle must be lined up as nearly as possible with the most accurate spindle, and in commercial practice too much time cannot be taken, as it is very costly to shut down machines. A small special grinder was designed; the shank was placed in the corrected spindles and the chucks ground. This grinder occupies less space than a "Dumore" grinder, which is too large to be used on some classes of machines, and it has proved quite efficient for multiple-spindle machine work. The grinder is illustrated in Fig. 2, and it will be noted that the shank is not integral with the spindle bearing, but allows the spindle to be swung around the pin *A* by adjusting the screws *B*. By this adjustment the depth of the cut is regulated. The plug *F* screws into the rear of the machine spindle and forms a bearing for the driving shaft through which power is transmitted from the pulley *G* to pulleys *D*, *C*, and *E*.

The time required for a man who is familiar with this class of machine to line up the machine by scraping the bearings is twenty hours, and an additional ten hours is required for grinding. The machines for the next operation on the fuse are equipped with special screw-in chucks with a pilot and draw-back arrangement, as shown in Fig. 3. *A* is the chuck proper, into which the fuse body screws, and *B* is the pilot, which does the centering; the pilot is lined up with the spindle by grinding. The allowable variation in the diameter of the hole into which this pilot fits is ± 0.0015 inch. The draw-rod *C* pulls back the threaded portion of the chuck, binding the fuse body on the bottom at *D*.

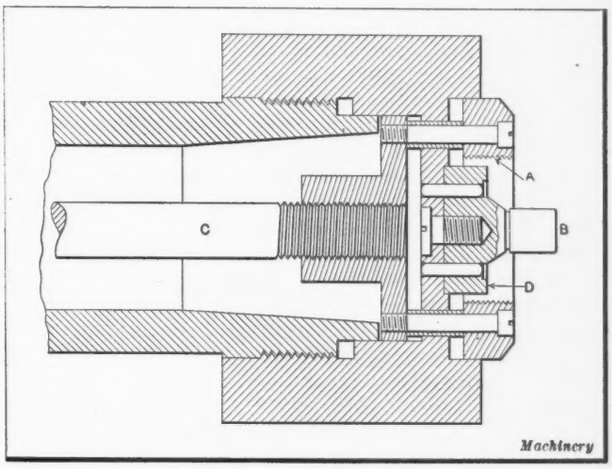


Fig. 3. Special Chuck for holding Fuse Body

Montreal, Quebec, Canada G. C. WHITE

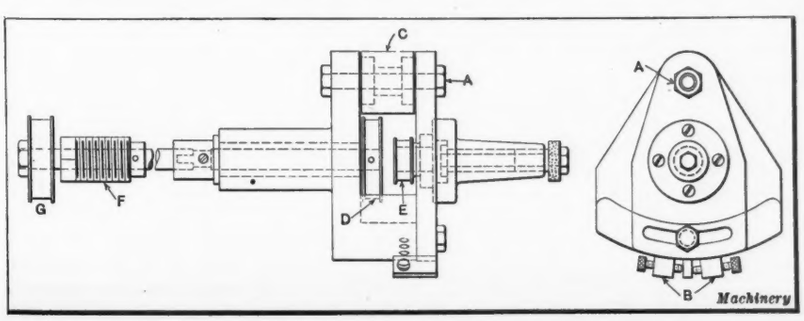


Fig. 2. Grinding Attachment for lining up Spindles

STRENGTH OF SPIRAL-TYPE BEVEL GEARS—A COMMENT

In reading the article by Reginald Trautschold in the August number of MACHINERY entitled "Strength of Spiral-type Bevel Gears," we note the statement made in the second paragraph with regard to the difference in angle of the inside and outside of the cutter blades. This statement is correct, but Mr. Trautschold's deduction that the pressure angles of the engaging faces of gear and pinion teeth are different from each other is not correct. The manner in which the cutter is set with relation to the work on the machine is such that the effective pressure angle produced on the work, measured with relation to the pitch cone surface, is not the same as the pressure angle of the cutter blade itself, but the cutter settings are so computed that these effective angles of the two engaging teeth match each other. The whole theory of determining cutter settings is based on this fact.

We quite agree, however, with the author's conclusion that spiral-type bevel gears are stronger in use than straight-tooth bevel gears. One of the chief reasons for this is that there are more teeth in contact and the load does not fall as heavily on any one tooth. Another reason is that the load is never concentrated on the point of a tooth for its whole length. When there is contact at the point on one end, the contact is toward the flank at the

other end, and the average height at which the load is applied from the root is much less than the total height of the tooth. The strength of teeth of this kind may also be compared with the strength of herringbone spur-gear teeth, where one favorable factor is the smoothness of running and the consequent increased loads possible.

A. L. STEWART
Gleason Works
Rochester, N. Y.

SIZING OPERATIONS FOR INCREASING PRODUCTION

In munition work, especially, minutes mean dollars, and any device or appliance which will relieve skilled men and expensive machinery is welcomed. The heavy demand upon the rolling and stamping mills has resulted, in many cases, in the production of stock rod brass and steel of varying diameters, different degrees of hardness, and a lack of uniformity in almost every detail. To cope successfully with this condition much avoidable labor has been imposed on machine operators, especially of automatic screw machines. The increased demand for capable screw machine men in new plants getting under way has scattered the good men of a few years ago and advanced them mostly to executive capacities. Their places have been filled, to a large extent, with practically inexperienced men, and therefore the factory manager devotes most of his time to high production against increasingly low standards of efficiency in the regular run of machine tool setters and adjusters. A concern working on large fuse contracts was confronted with this problem. A partial solution was found by the use of simple sizing operations, manned, for the most part, by female operators.

The sizing operation on screw machine products has many advantages and results; namely, it relieves the tool setter, however skilled he may be, of constant attention to close sizes and finish, and, as a result, his entire energy is directed to speed and continuous production. It gives a uniformity of product and finish exceeding that of individual effort on the part of many tool setters. It also saves stock, as many parts can be made of stock size rod by the use of a simple shearing die for the outside diameter, where it would be otherwise impossible, owing to variable dimensions or to scant allowances for proper shaving to size. The illustrations show two applications of simple sizing operations, each of which has proved successful, not only mechanically but from a production point of view.

The government inspector, finding that every piece is an exact duplicate of the standard sample, in both size and finish, will look more favorably on any new similar operation which may be introduced from time to time. The advantages gained by pleasing the government inspector are too obvious to need further explanation. The gaging expense is eliminated in many instances, as the operation itself is really a gaging process, especially when it is a hand operation.

The accompanying illustration Fig. 1 shows a shearing die mounted on a small arbor press for sizing graze pellets for the No. 101 graze fuse. These pellets were formerly made on an automatic screw machine, but required shaving on the outside to produce the accuracy and finish demanded by the government inspection. The shearing die illustrated produces a much better finish and raises the production fully 30 per cent. In Fig. 1 is shown a graze pellet *C*. The die *D* is held in body *G*, plate *F* being simply a guide for locating pellet *C* concentric with the die. When the pellet is in place, punch *E* forces it through die *D*, thus producing the required finish and accuracy. Fig. 2 shows a sizing fixture for sizing the pellet plugs used in the No. 101 graze fuse. The thread dimensions must be held within accurate limits. It was found that when the slot in the head was cut, it produced objectionable burrs, which resulted in the rejection of many of these parts by the government inspection. To overcome this, it was decided to rough-thread in the automatic machines, slot, and then size in the special fixture as shown in Fig. 2. The pellet plug *H* is placed in the tube *J* and forced into contact with the threads of button die *K*, by means of the hand-lever *I* which also prevents the turning of the pellet plug while passing through the die by means of the screwdriver end which fits in the slot of the pellet plug. After passing through die *K*, the work drops through slot *N* into a box. Button die *K* is held in body *L*, which is turned slowly by arbor *M*. This method proved entirely satisfactory.

In the present crisis, we owe it to our country and ourselves to help the production all we can. These two simple examples and the way in which the simple methods may be applied to the common difficulties met with in the screw department may be of help to others.

A. F. OWEN
Toronto, Ont., Canada

WEAK HANGER CONSTRUCTION

The editorial entitled "Weak Hanger Construction" in the July number of MACHINERY brings to mind a point in connection with ball-bearing hangers that is seldom emphasized in discussions of that type; that is, that due to the shape of the bearing housing, the hanger frame is necessarily wide and yet hugs the housing. Hence, the hanger construction is both rigid and strong, and any danger from supporting screws being too long is obviated.

JOHN KEPKE, JR.
First Lieut., C.A.R.C.
Fort Monroe, Va.

METHOD OF DISTINGUISHING "GO" AND "NOT GO" ENDS OF PLUG GAGES

In reference to the article entitled "Distinguishing Marks for Ends of Plug Gages" on page 1139 of the August number of MACHINERY, the writer would like to say that the usual practice of large toolmaking firms is to make the "Not Go" plug only about half as long as the "Go" plug. As the "Not Go" plug never goes into the hole there is no reason for making it as long as the "Go" size, and we have, therefore, a readily distinguished mark. This practice results in a saving of stock and the amount of time required in lapping.

T. A. REILLY
Hartford, Conn.

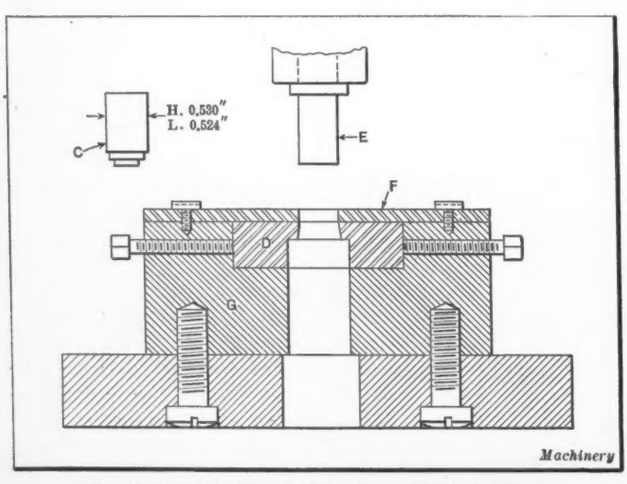


Fig. 1. Shearing Die for sizing Graze Pellets for Fuses

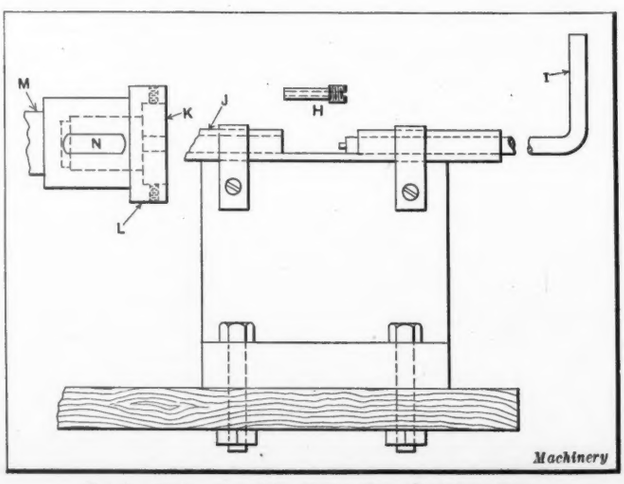


Fig. 2. Fixture for sizing Pellet Plugs for Graze Fuses

SHOP AND DRAFTING-ROOM KINKS

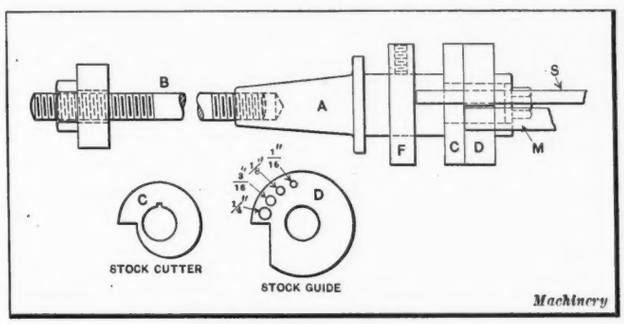
PIERCING FLAT SPRINGS

Flat coil springs from old clocks or motors are often used to good advantage in the making of special flat springs for odd jobs in the machine shop. Because of the temper of these springs, it is impossible to drill the necessary holes without much grinding of the drills. Neat and accurately located holes, however, can be made by laying the springs on a piece of lead or babbitt metal and then punching the holes with a regular drive-pin punch of the required diameter.

New York City — E. J. HIGGINS

TOOL FOR CUTTING OFF DOWEL-PINS

The accompanying illustration shows a device for cutting off dowel-pins in a lathe. The arbor *A* is tapered to fit the lathe spindle and is firmly clamped in position by the bolt *B*.



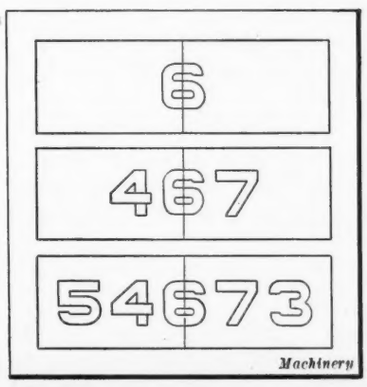
Tool for cutting off Dowel-pins

The cutter *C* is keyed to the body, while the stock guide *D* is a running fit, but is held stationary by means of a tool or block *M* clamped in the toolpost and against which the stock guide rests. In operation, the stock *S* is placed in the proper diameter hole of the stock guide and pushed up until stopped by the length gage *F*. A shearing effect is produced, and stock up to ¼ inch in diameter can be cut quickly and successfully with the lathe running at a fairly high speed.

Flint, Mich. — C. C. SPREEN

DOING NEAT STAMPING BY HAND

When stamping figures on work that requires equal side borders, it is best to begin with the central figure and to work toward each side. For instance, in the accompanying illustration, the figure 6 is stamped first, then the figures on each side, as shown, until the work is completed. The same principle of laying out is used with letters, though a consideration of the variation of the relative width of the letters and the spaces between them is necessary. The letters M and W are three-tenths greater in width than E, F, P, and R; and the latter are one tenth less in width than any other letter. The letter I is in a class by itself.



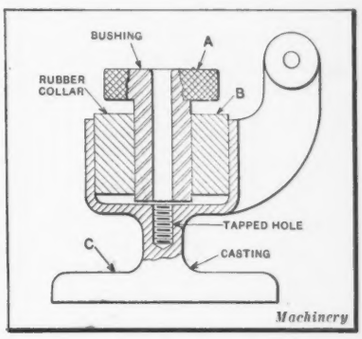
Laying out Figures and Numbers for Stamping

When stamping, the first hammer blow should have merely enough force to make a visibly level impression on the work. This will serve as a guide to the correct location for the letter; and as the impression is shallow, the punch can easily be moved in the direction that may be necessary before the letter is cut to the full depth.

New York City — E. J. HIGGINS

RUBBER JIG

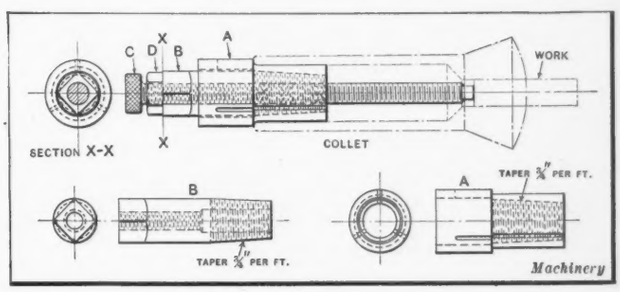
The accompanying illustration shows a jig of unusual and interesting design. The purpose of this jig is to locate the tapped hole shown in casting *C* approximately concentric with the bowl or large hole in the casting, which is not machined and is subject to a variation in size. To compensate for this variation, the drill bushing *A* is fitted with a rubber collar *B*. The rubber collar readily adjusts itself to any variation that may exist in the castings and allows the jig to be quickly removed or inserted. Collar *B* allows bushing *A* to be brought into perfect alignment with the drill. The casting with the jig in place is placed on the table of a sensitive drilling machine and lightly spotted with a drill guided by bushing *A*. After this is accomplished, the hole is drilled and tapped in the usual way. L. G. C.



An Unusual Type of Jig

STOP FOR SPRING COLLET

The stop shown in the accompanying illustration is designed for use in a spring collet. It is particularly useful in locating dowel-pins and work of a similar nature where pieces are to be faced off to the same length. This stop makes it unnecessary to employ the cut-and-try method, and therefore eliminates the time spent in taking each piece out of the collet and measuring it. It consists of an expanding bushing *A*, which is expanded by the taper screw *B*, being screwed into the tapered portion; *B* also acts as a nut for the stop-screw *C*. Check-nut *D* locks the stop *C* in position. The stop is inserted in the collet as shown, and held in place by expanding bushing *A*. Stop *C* is then adjusted and held in place by lock-nut *D*.



Stop for locating Work in Spring Collet

Boston, Mass. — J. A. SHAND

CHILLED CASTINGS

The hardness of chilled surfaces may be materially reduced by giving the surface of the chill in the mold a thin coating of tar or pitch. In one case, the use of a coated chill on a bracket seat saved from twelve to fifteen minutes on the time previously required for machining. When uncoated chills were used, the bracket seats were generally too hard for machining.

Toronto, Ont., Canada — H. POLLARD

HOW AND WHY

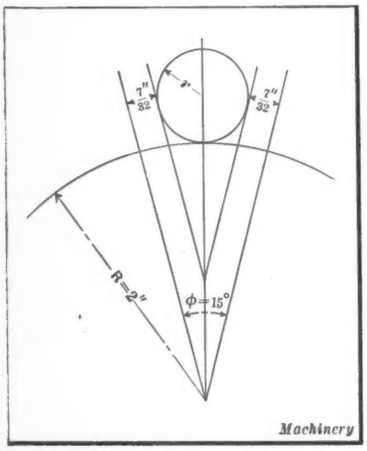
QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

FINDING RADIUS OF CIRCLE

L. A. Z.—Will you please show me how to find the radius r from the dimensions given in the accompanying illustration? I should like a formula for all such cases.

Answered by Walter H. Webster, Cincinnati, Ohio

It is possible to find the radius of the small circle in the accompanying illustration by a simpler method than that given on page 1043 of the July number of MACHINERY. As $R + r$ = distance between the centers of the circles, $\frac{r + 7/32}{R + r} = \sin 1/2\ \phi = \sin 7$ degrees 30 minutes = 0.130526. As $R = 2$ $\frac{r + 0.21875}{2 + r}$ = 0.130526 and $r + 0.21875 = 0.130526\ (2 + r)$, $r - 0.130526r = 0.261052 - 0.21875$; therefore, $0.869474r = 0.042302$ and $r = 0.042302 \div 0.869474 = 0.04865$ inch.



Determining Radius of Circle

CUTTING SLOTS IN WIRE GAGES

W. B. D.—How are the small slots cut in standard wire gages, for example, slots as narrow as 0.004 inch in width? Are cutters used thin enough for this work?

A.—The smallest slots in standard wire gages are cut with circular cutters thin enough to produce the required depth of cut.

PROBLEM IN TRIGONOMETRY

C. E. M.—Referring to the accompanying illustration, please show how to find the angle ϕ. I should like to have the method explained in detail.

Answered by Walter H. Webster, Cincinnati, Ohio

There is an easier method of solving the "Problem in Trigonometry" than the one given on page 1042 of the July number of MACHINERY, where the angle ϕ is to be found. All the known values are given in the accompanying illustration. As OC is perpendicular to CD and OA is perpendicular to GB, angle ϕ = angle ω and angle ω = angle θ — angle δ. $OF = OA + BD = 0.205 + 0.040 = 0.245$ inch and $OD = \sqrt{OC^2 + CD^2} = \sqrt{0.217^2 + 0.138^2} = 0.2572$ inch. Cos $\theta = \frac{OC}{OD} = \frac{0.217}{0.2572} = 0.8437$, which is the cosine of an angle of 32 degrees 28 minutes. Cos $\delta = \frac{OF}{OD} = \frac{0.245}{0.2572} = 0.95257$, which is the cosine of an angle of 17 degrees 43 minutes. Angle ω = 32 degrees 28 minutes — 17 degrees 43 minutes = 14 degrees 45 minutes, which is, therefore, the size of angle ϕ.

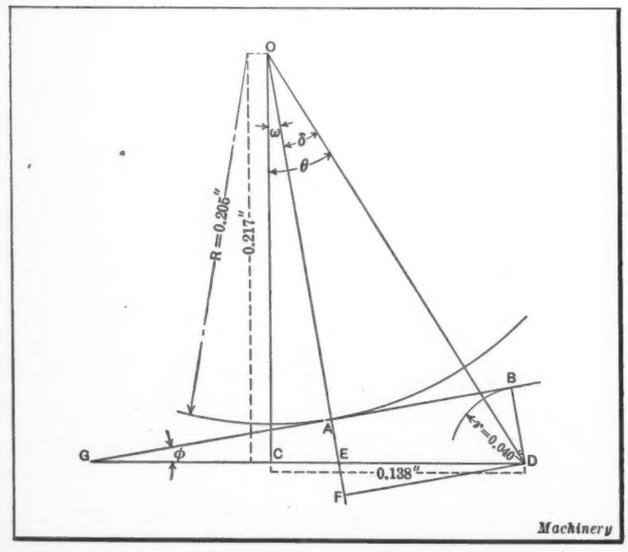


Diagram illustrating Problem in Trigonometry

A TOOLMAKER'S PROBLEM

A. S.—I am a toolmaker with but slight knowledge of mathematics. The following problem came up recently in connection with my work, which I am unable to solve. Please show me how to find x to the nearest thousandths of an inch.

Answered by I. E. Snyder, Bridgeport, Conn.

In the solution of "A Toolmaker's Problem," on page 837 of the May number of MACHINERY, quadratic equations are used. It is possible to solve this problem by a much simpler method than is there given and one that requires only a slight knowledge of trigonometry. Referring to the accompanying illustration, angle δ is easily found, for its tangent is:

$$\frac{AC}{BC} = \frac{2.053}{2.380} = 0.8626$$

which is the tangent of an angle of 40 degrees 47 minutes. The side AB of the right triangle ACB is also readily found, being $\sqrt{AC^2 + CB^2} = \sqrt{2.053^2 + 2.380^2} = 3.1431$. Then angle θ may be found, for its sine is:

$$\frac{AD}{AB} = \frac{1.200}{3.1431} = 0.3818$$

which is the sine of an angle of 22 degrees 27 minutes. As angle ϕ is the sum of the two angles just found, ϕ = 40 degrees 47 minutes + 22 degrees 27 minutes = 63 degrees 14 minutes. Angle α = angle ϕ and angle $\gamma = \frac{1}{2}\alpha$; therefore,

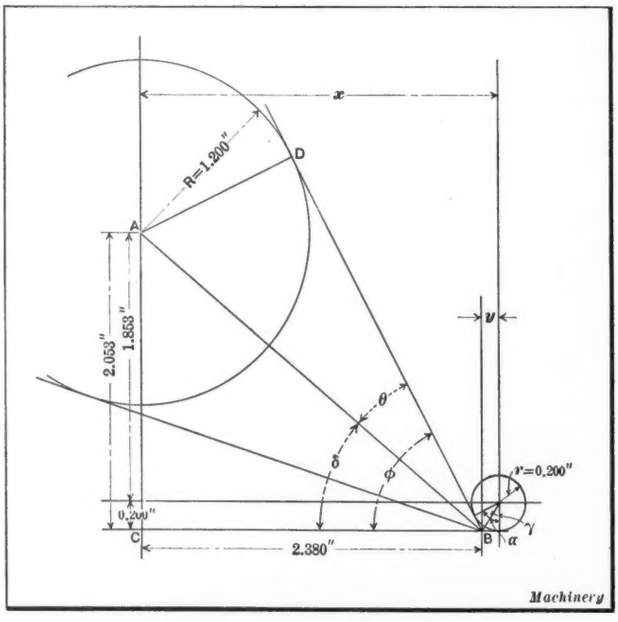
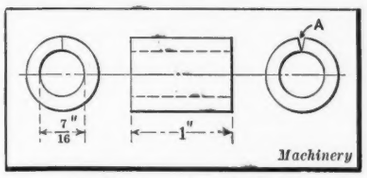


Diagram illustrating a Toolmaker's Problem

$\gamma = \frac{1}{2} \times 63$ degrees 14 minutes = 31 degrees 37 minutes. Distance y may now be found, for it is $r \tan \gamma = 0.200 \times 0.61561 = 0.12312$ inch. Therefore, the distance x between the centers of the circles is $0.12312 + 2.38 = 2.5031$ inches.

DIE FOR FORMING THIMBLE

F. M. H.—In the accompanying illustration is shown a thimble 1 inch long, made from No. 10 gage strip band iron, with a 7/16-inch hole that should be as nearly round as possible. Can a die be made to form this thimble in one operation; if not, how many operations will be required? Will some reader of MACHINERY suggest a die that will form this thimble without leaving an opening as shown at *A*?



Thimble to be formed by Die

Answered by Henry Daut, Plainfield, N. J.

Although the punch and die shown in Fig. 1 involves no new principle in its design, it is of considerable interest owing to the heavy material it is intended to form. The writer believes, however, that it is impossible to form a thimble of this size with a wall of 0.140 inch, having a close seam, unless the ends of the blank are beveled before forming. The punch consists of the following parts: Top, plate *A*, having stem to fit press, is securely screwed and doweled to plate *B*. The stamp *C* is located in the center of plate *B*, and directly behind the stamp is a slot in which part *D* is a sliding fit. A 7/16-inch arbor *E* is driven into the lower end of part *D* in a position parallel to the stamp. A spring *S* forces part *D* downward until it is checked by a 3/8-inch screw *F*, which engages a slot in the back side of the slide. The arbor *E* is then held in a position directly below the stamp *C* and 5/8 inch from its lower edge. At both ends of plate *B*, slots are cut for sliding arms *G*, which are held down by light springs *H*. Directly above arms *G* and in a horizontal position are slides *I* provided with a handle *J*. When the handle *J* is pulled out, arms *G* will have a clearance of 5/8 inch at the top; when the slides are pushed in, arms *G* are held firmly in place.

The lower part of the die consists of a cast-iron body *K*, in which the forming dies *L* are a sliding fit. A pad *M* having the same radius as the finished thimble is fastened in the center of body *K*. Dies *L* are forced apart against stop *N* by means of springs *O*. The thimble blank is held in place by 1/8-inch pins *P*, shown in Fig. 2. The thimble is formed by two blows of the press. The view at the upper right-hand corner of Fig. 2 shows the first action of the die. The slides *I* are pulled out, thus allowing arms *G* to compress springs *H* shown in Fig. 1 at the instant arms *G* come in contact with dies *L*. The dies *L*, therefore, remain idle while the punch is forming the U-shaped blanks which remain in the die. The slides *I* are then pushed in ready for the second blow. As soon as arbor *E* reaches the bottom, the arms *G* come into action and press dies *L* together. At the instant both ends of the blanks meet, stamp *C* drops and closes the thimble. The finished thimble can then be removed from arbor *E* by a small hand press.

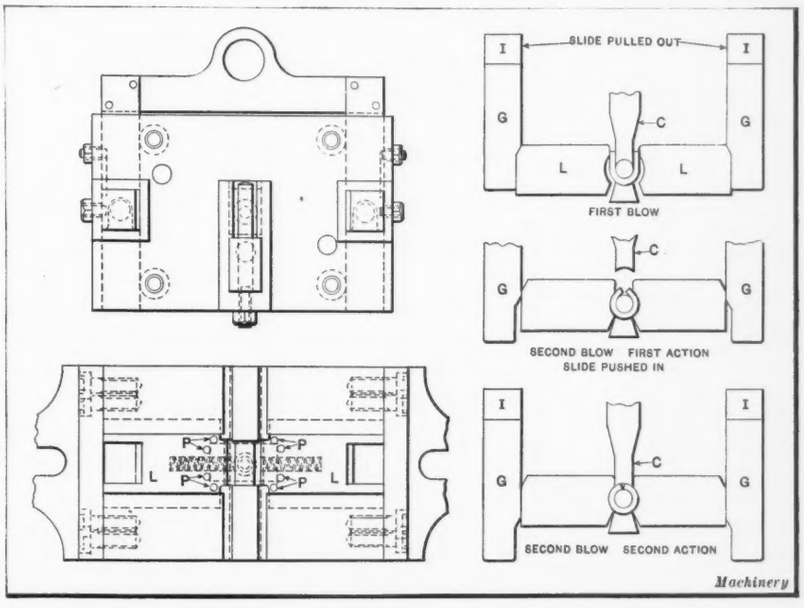


Fig. 2. Bottom View of Punch and Top View of Die, and Views showing Forming Operations

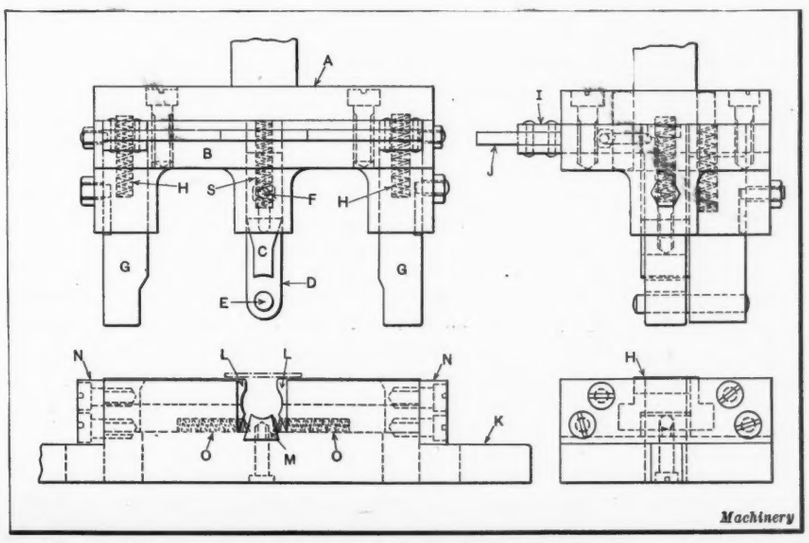


Fig. 1. Punch and Die for forming Thimble

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EXAMINATIONS IN MACHINE SHOP PRACTICE

On page 844 of the May number of MACHINERY there is given a novel and interesting method of examination in machine shop practice. While by that method records of the term's work are kept, a mark for this work is not included in the examination percentage finally issued. In the article referred to it was stated that the chief trouble was the production of a good notebook; this same difficulty has been found in other establishments. In the applied mechanics laboratory of the Sheffield University, England, the teachers have always insisted upon a weekly entry of the class work in a good exercise book. This entry is examined and, when found necessary, the student makes corrections in the report before other work is undertaken; a mark is given for each finished entry of an exercise. This method has produced some excellent results which are shown in the later work of the students possessing such books. The final marks are given on the following basis: 25 per cent for the results of the entries in the book referred to, 25 per cent for a two-hour examination in laboratory practice, 40 per cent for a two-hour examination in lecture work, and 10 per cent for the record of results from the working of weekly examples. The doing of the weekly examples and the entry in the notebook constitute homework. The results of the last term examination fully justified this method, for the man who could be considered the cleverest student in the class was tied for honors with the man who was not merely clever, but the greatest worker in the class, and at the same time had good general ability. This method of marking analyzes the students' abilities better than a final examination, when a pupil may be nervous and suffer unjustly. G. S. B.

REDUCING COSTS FOR SPECIAL MANUFACTURING EQUIPMENT

BY F. E. JOHNSON[1]

At the present time when manufacturers are handicapped by the lack of competent workmen, more highly developed mechanical equipment must be utilized. Where the manufacturer produces parts in quantities the automatic machine may be used to the best advantage. Then an attendant, with but little training, can care for a number of machines, if his duties are only to provide the machine with work, and to remove the work when operations are completed, which is generally necessary for most classes of work, outside of the various types of screw machines that operate on bar stock, and machines equipped with hopper feeds. With the exception of set-up men, skilled labor is not required where automatic machines are used. The value of such equipment for quantity production and as a means for reducing manufacturing costs is generally recognized by manufacturers.

The automobile industry gave a decided impetus to the development of manufacturing machines of high productive capacity that would not require skilled men for operating them. If such machines were more universally utilized by the small manufacturers of specialties, and others, than is the case at the present time, they would be enabled to improve quality, and increase output at a smaller operating expense and by such means maintain a minimum in manufacturing costs.

The possibilities for equipment of this kind as yet are not generally understood. Machines built for a single purpose are termed special machines, and in designing them little thought is sometimes given to adapting them for any purpose other than the one in mind. Consequently, considerable capital is invested in a machine that cannot be used for anything but a certain operation or series of operations. The average manufacturer who sees possibilities for special machines in his factory is, therefore, slow to take steps in this direction because of the expense involved.

If the problem of special equipment is handled in a broad manner and the requirements of a number of machining problems are considered, rather than some individual ones, and steps are taken to decide upon a common type of machine that may be partly, if not entirely, adaptable to a number of purposes, the first cost of such machines can be held to a reasonable figure. The objective should be to have some standardization, so that a machine will not be a total loss if changes are made in the design of a product. The important members, such as the frame or bed, camshaft driving mechanism, main slides, etc. should be universal for one and all machines. For certain classes of work and for such operations as milling, drilling, reaming, turning, facing, counterboring, tapping, etc., an automatic machine can be developed of the cam-operated type which can have the universal features outlined. Ordinarily the designer of special machines is inclined to follow too closely the ideals and refinements of machine-tool design. This is very natural, as in the process of designing he seeks adaptable construction ideas by studying machine-tools, catalogues, and other literature. The element of pride in accomplishment becomes a strong factor and the finished product is a thing of beauty in outline and detail, but too often poor in construction principles.

The cost of special equipment should not be prohibitive if the proposition is handled well. Attachments with which a machine tool is fitted may be eliminated; only one speed and one feed are necessary. The most efficient speeds and feeds for obtaining the maximum output can be determined before a machine is put into service.

In one large sewing-machine plant, automatic machines have been used almost exclusively for the past twenty-five years or more in the production of parts for the common types of their product. These machines have been designed by the engineering force and are built on an extensive scale. The earlier ones were very simple in construction but efficient and effective for the purposes intended. They were for the most part designed on the type principle, with the object of lessening expense and speeding their construction. The time elapsing between the conception of the idea and the completion of the machine was sometimes remarkably short. They were built from patterns carried in stock and such special ones as were necessary. Most of them were cam-operated and of the open type of construction, so that all parts were easily accessible for repairs; gear and pulley guards were generally made of sheet metal. These machines did not have the many refinements of modern machine tools, but they were constructed well and were cost-reducing producers.

The matter of designing important members that will be common to a number of machines is not a difficult problem if designs are not too complicated. Simplicity is the keynote to success in this work. Machine-tool builders are making and have made changes in designs to meet demands for greater simplicity. The designer of special machines will also do well to go back to the simpler forms—results are what count.

[1]Address: 858 Bergen St., Newark, N. J.

* * *

Saving fuel is, perhaps, one of the most imperative of the many war economies that must be imposed upon the American people. The Bureau of Oil Conservation of the United States Fuel Administration wishes to impress upon everyone the importance of taking immediate steps to prevent unnecessary and avoidable waste of fuel oil. It is necessary to conserve fuel, and it is the patriotic duty of everyone to have furnaces, boilers, and fuel oil equipment thoroughly inspected and any waste stopped.

Attention is called to the following suggestions on handling and burning fuel oil:

When unloading tank cars, use great precaution to prevent the loss of oil in uncoupling the discharge pipe.

Stop all leaks in oil pipe lines, fittings, valves, and storage tanks, and see that all tank openings are kept closed. Storage tanks should be equipped with steam heating coils.

Install efficient burners. Homemade burners are usually crude and consume an excess of oil.

Install strainers. Dirty oil clogs the burner, slows up heating operations, and increases fuel consumption.

Install duplicate pumping systems, and pump the oil to the burners under a uniform and constant pressure.

Install suitable preheaters, in order to obtain proper atomization, clean combustion, and prevent the formation of carbon. This is especially necessary with heavier gravity oils.

Use pyrometers in all heating and heat-treating furnaces. The operator may have good eyesight, but he cannot always judge heat by color. If there is a higher temperature than necessary, fuel is being wasted.

Impress upon furnace operators the necessity of conserving fuel by keeping their furnaces and equipment in the best condition possible, in order to obtain the maximum of economical efficiency.

Oil meters should be installed so that a record of daily consumption may be kept and compared with previous data, and the decrease in the amount used noted.

Have sufficient oil capacity to avoid shut-downs when oil shipments are delayed. Shut-downs mean a loss of heat and added fuel consumption.

Operate furnaces twenty-four hours a day when possible.

* * *

Those whose circumstances are such that it is impossible for them to buy Liberty Bonds can help to win the war by buying Thrift Stamps and War Savings Stamps.

The fourth Liberty Loan campaign will begin Saturday, September 28 and close October 19. No good American will fail to contribute to its success to the very limit of his or her ability. The blood of young American men fallen in Europe calls to us. Our answer must be and will be worthy of them and of the ideals of liberty and justice for which our country stands.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

Wright Dieing Machine. Henry & Wright Mfg. Co., Hartford, Conn. 73
Lees-Bradner 155-millimeter Shell Threading Machine. Lees-Bradner Co., Cleveland, Ohio 75
Fafnir "Dragon" Type Ball Bearing. Fafnir Bearing Co., New Britain, Conn 75
Ferracute Power Press. Ferracute Machine Co., Bridgeton, N. J. 76
Chain for Hanging Pipe. Cleveland Galvanizing Works Co., E. Cooper Ave. and Pennsylvania Railroad, Cleveland, Ohio .. 76
Blevney Motor-driven Wheel-type Cushion Polishing Machine. Blevney Machine Co., Greenfield, Mass. 77
M. B. Hill Production Drill Jig. M. B. Hill Mfg. Co., 6 Eden St., Worcester, Mass. 77
Victor Adjustable and Collapsible Hand Sizing Taps. Victor Tool Co., Waynesboro, Pa. 77
"Velox" High-speed Vise. Velox Vise Co., Inc., Lowville, N. Y. ... 78
Paschall Lathe Attachment. Paschall Tool Co., 510 Long Beach Bank Bldg., Long Beach, Cal. 78
New Britain All-steel Work-stand. New Britain Machine Co., New Britain, Conn. 78
Eastern Tube & Tool Co's Drill Chuck. Eastern Tube & Tool Co., Inc., 41-59 Gardner Ave., Brooklyn, N. Y. 79
Defiance Boring, Milling, Drilling, and Tapping Machine. Defiance Machine Works, Defiance, Ohio 80
David A. Wright Planer. David A. Wright, 568 Washington Blvd., Chicago, Ill. 80
Coats Precision Fluid Gage. Coats Machinery Co., Land Title Bldg., Philadelphia, Pa. 81
Nielsen & Winther Lathe. Nielsen & Winther, Ltd., 59-61 Pearl St., New York City 81
Grove Indicating Gage. Grove Mfg. Co., Dayton, Ohio 82

WRIGHT DIEING MACHINE

This machine is adapted for the performance of those classes of manufacturing operations that are usually handled in dies operated by a power press. Hence, the term "dieing" machine was adopted with the view of explaining the range of work that can be done by this machine and at the same time distinguishing it from the various familiar types of power presses.

IN the accompanying illustrations is shown a dieing machine which is one of the latest products of the Henry & Wright Mfg. Co., Hartford, Conn. This machine is adapted for the performance of blanking, forming, drawing, piercing, coining, and other operations which are done in dies operated by any type of power press.

This dieing machine consists principally of the following parts: An upper head or plate to which the punch or upper member of the die is attached; a frame, the upper part of which forms a table or support for the bolster on which the die or lower part of a pair of dies is supported; four guide rods which pass through guiding bushings in the frame and which connect the four corners of the upper head or plate with the four corners of a lower plate or cross-head located inside the frame or column of the machine; and a connecting rod which connects this cross-head with a crankshaft, the latter, in turn, passing through bearings in the frame of the machine and extending outward in one direction for mounting a driving pulley and braking pulley upon it.

On account of the construction of the machine, there are only direct tensional and compression strains in all members. The tensile stresses are exerted upon bars made from steel, and the upper die is drawn down onto the lower die by the four guide rods attached to a solid plate at the four corners. This prevents the punch and die from being tilted with relation to each other, even in the slightest degree, prevents the breaking of punches, and also makes it possible to have the punches fit the dies accurately when required. The power is conveyed to the machine through the driving pulley mentioned, thence through the crankshaft and connecting-rod inside of the frame to the cross-head, to which, in turn, the four guide rods are attached, that pull down the upper head with its punch or die. In addition to the guide rods, solid guide slides are also provided on the inside of the frame, one on each side of the cross-head, so that its motion is absolutely controlled. Beneath the lower cross-head, springs are provided to prevent a sudden drop at the lower end of the stroke as the punch passes through the metal being cut. The position of the punch or upper die may be adjusted by means of nuts on the connecting-rod, which may thereby be lengthened or shortened.

The machine is furnished with a safeguard or hood with glass plates on the sides, making it possible for the operator to see clearly what is going on between the dies, but making it impossible for him to place his fingers between the tools. A safety lock is provided so that when the guard or hood is raised, it is impossible to start the machine. A stop for the hood is also provided so that when let down it will stop at any required predetermined position. On the side opposite to where the stop-rod is placed, a guide rod for the hood is provided. The machine may be started either by operating a lever on one side, near the driving pulley, which will permit continuous operation, or it may be started by a foot-lever, in which case it will make one stroke only and then stop until the foot-lever is brought up and then again brought down. The safety lock, which operates when the guard over the dies is in its upper position, controls both the foot-lever and the lever for continuous operation, so that it is impossible to start the machine by either method until the guard is let down.

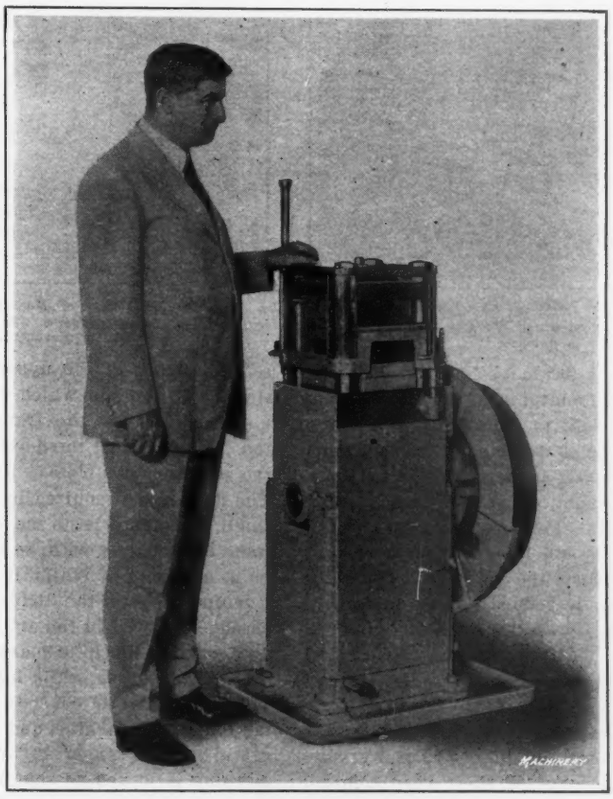


Fig. 1. Front View of Wright Dieing Machine, showing Foot-lever for Single-stroke Operation and Hand-lever near Wheel Guard for Continuous Operation

This machine contains some very marked departures from current practice in the design of machines for dieing sheet metal. The chief claims which the manufacturers make for this machine are as follows: There are no torsional or ripping strains throughout the machine, the strains being wholly tensile and compressive, so that the danger of injury to the machine through overloading is almost entirely eliminated. On account of the fact that it is impossible for the dies to be thrown out of perfect alignment with each other, they should last several times as long as usual, remain sharp for a longer period, give more perfect edges to the work, and in blanking, eliminate burrs to a great extent. These claims are not theoretical, but are based on the comparison of the well-known results obtained by the use of dies in the device known as a "sub-press" and those used in open-face machines.

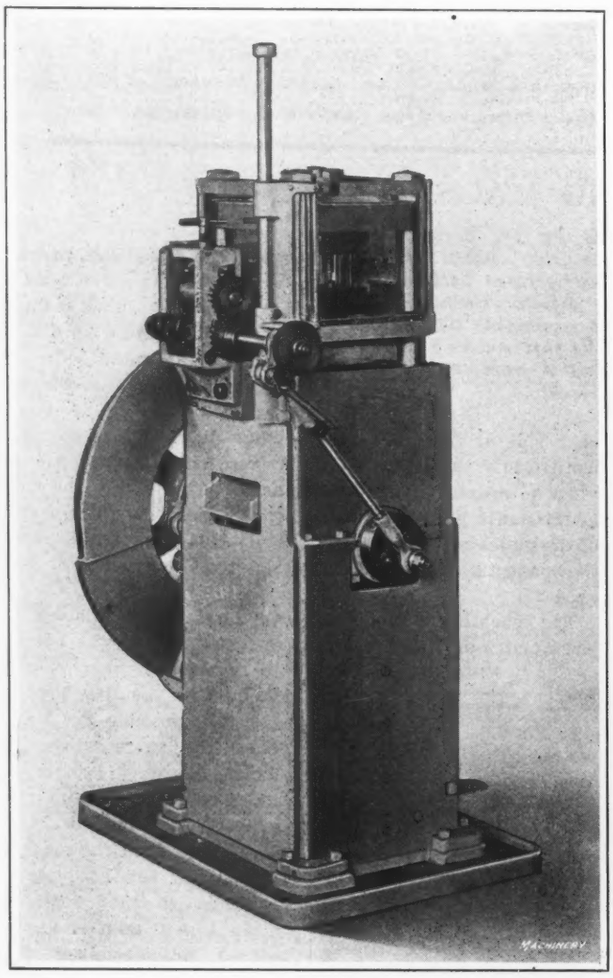


Fig. 2. Front and Left-hand Side of Machine, showing Roll Feeding Device and Mouth of Chute from which Work is ejected after Operation is finished

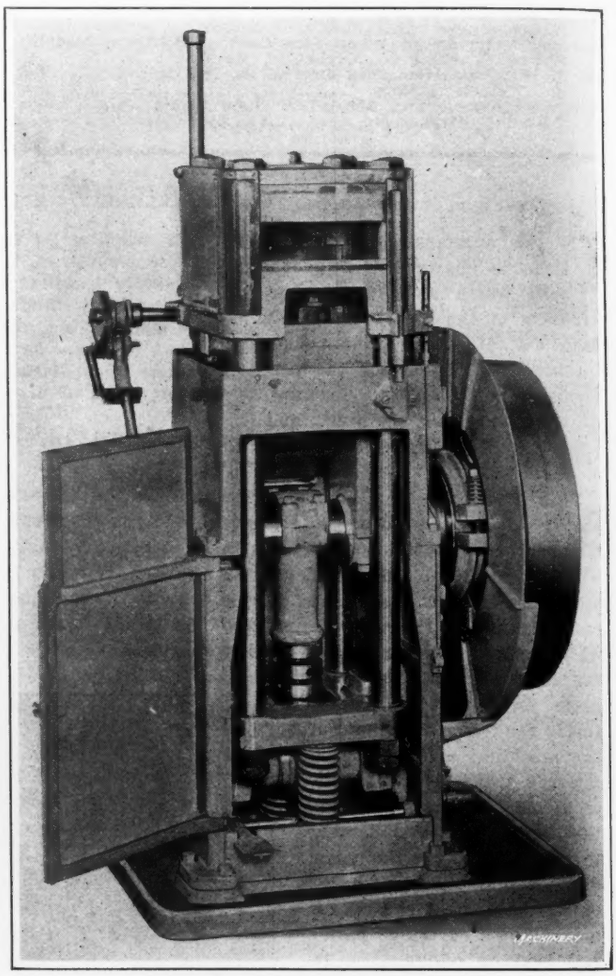


Fig. 3. Side View of Machine with Door Open to expose Internal Mechanism to View. A Simple Crankshaft is shown, but Any Form of Eccentric Mechanism may be substituted

The driving mechanism is all located below the die-plates instead of above as on most other machines, thus doing away with the great obstruction to light and making the machine better balanced so that it can be constructed with very much less weight for the same strength as heretofore. In consequence of the better balanced condition of the machine, it is said to be less noisy than others. Felt protected dust guards surround each of the four shafts and liberal oil-cups are provided within easy reach throughout the machine. The chute is covered with leather in order to reduce to a minimum the sound of the blanks falling into the chute. The design of the machine lends itself to the use of various attachments, such as finger motions, automatic feeding mechanisms, scrap cutters, dial feeding devices, etc.

As will be readily seen, the posts form a natural hub for the attachment of dial feeding devices and there are many ways in which these machines, on account of their very compact design, may be advantageously used in groups, a case in point being the placing of a line of machines under a bench of the height of the dies and run by belts attached to pulleys on a lineshaft underneath the bench. A thorough search throughout the art of metal dieing has failed to result in finding a single instance where the upper dies have been pulled down by power applied from underneath, so that the patents on these machines may be said to be almost basic in character and they are issued or pending in all the countries where any great interest is taken in metal dieing. Attention is called to the fact that in this machine the upper die is supported on four sides, so that its accurate alignment is assured. Excellent illumination of the space around the die can also be provided. This machine is not an experiment; it has been fully tried and has proved to contain all of the advantages claimed for it, and these advantages increase with the size of the machine.

It will be seen at a glance that it is very easy to set the dies accurately in this machine, as it is merely necessary to set the shank of the upper die-holder through the top plate, tighten up the bolt which draws it up, fit the lower die to the upper one, lower the frame so that the lower die fits into the die bed, adjust the depth gage to the position required, and the setting is completed. It is almost impossible to go wrong. The floor space required by the new machine is comparatively small, and there is no moving mechanism for the operator to come into contact with, so that danger of accidents is reduced to a minimum. While it is generally conceded that some machines used in the dieing of metal are among the most dangerous employed in the art of metal working, the safety device used on this machine makes it impossible for an operator to start the machine while his hand is in a dangerous position. This safety device consists of a cage which fits entirely over the top of the machine, and the cage must be raised in order to get a hand or finger between the dies; when so raised, the machine is locked so that it cannot operate until the cage is lowered, in which position it is equipped with holes sufficiently large for the metal to be operated upon to enter, but not large enough for the entrance of either a finger or a hand. The

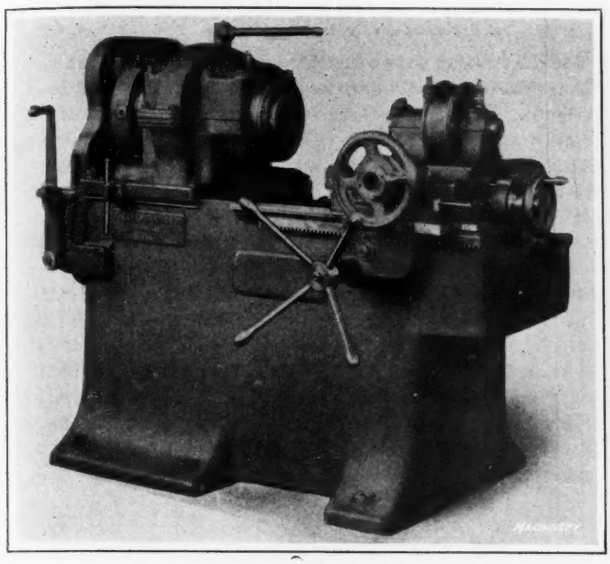


Fig. 1. Machine developed by Lees-Bradner Co. for milling Thread in Nose of 155-millimeter Shells

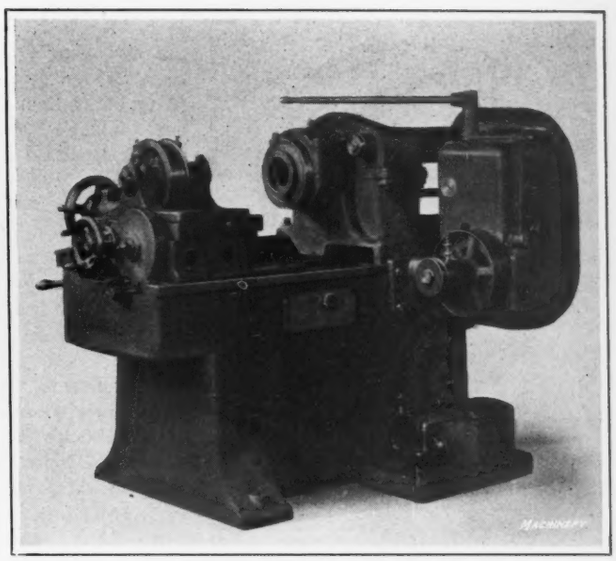


Fig. 2. Opposite Side of Lees-Bradner Thread Milling Machine shown in Fig. 1

machine may be operated either from a sitting or a standing position, and the dies may be fed from any one of the four sides.

The weight of the No. 1 machine is 1350 pounds and its rated capacity is 25 tons. The principal dimensions of the machine shown in the illustrations are as follows: Rated capacity, 25 tons; throw, 1½ inch; adjustment, 2 inches; distance between under side of top plate and working surface of machine when upper plate is raised to its highest point, 10½ inches; distance between vertical shafts, 8 inches; size of hole in center of working surface, 6 by 7 inches; diameter of flywheel, 24 inches; face of flywheel, 4 inches; weight of flywheel, 300 pounds; diameter of crankshaft, 3 inches; diameter of vertical steel shaft, 2 inches; floor space occupied, 24 by 31½ inches; and height of machine over all, 52 inches.

LEES-BRADNER 155-MILLIMETER SHELL THREADING MACHINE

The Lees-Bradner Co., Cleveland, Ohio, has just developed a thread milling machine arranged for milling the thread in the nose of 155-millimeter shells. A general idea of the machine itself may be obtained from Figs. 1 and 2, and the sectional view, Fig. 3, illustrates the method of holding the shell in the work-spindle. In the latter illustration the bearing is indicated at *A*, the spindle at *B*, the shell at *C*, the driving gear at *D*, the centering "plug" or sleeve for the shell nose at *E*, the positive opening and closing collet at *F*, the collet expanding ring at *G*, and the handwheel at *H* for operating the collet. The cutter-spindle and cutter-head conform to the standard Lees-Bradner design, and the machine is essentially a single-purpose one. The work-holding spindle with its positive opening and closing mechanism and shell locating device is an interesting feature of the machine. The centering sleeve *E* engages the nose of the shell, and the latter is forced into positive engagement with it by the inward movement of the collet at the rear of the head, as this collet is closed by turning the handwheel. The collet is made of special steel and subjected to a carefully conducted heat-treatment.

A ring on the handwheel engages an annular groove in the collet and closes it by forcing the tapered shoulder against the tapered section of the spindle. The points of contact with the shell body are at the two ends, assuring positive alignment and a concentric thread in the nose. The function of the expanding ring *G* is to engage the inclined, under-cut surface of the collet in order to open the latter positively, so that it will clear the bourrelet of the shell. The shells are loaded into the machine and withdrawn at the rear end of the spindle. Positive opening and closing of the collet allows the shell to pass freely in or out and makes it unnecessary to use any form of ejecting device.

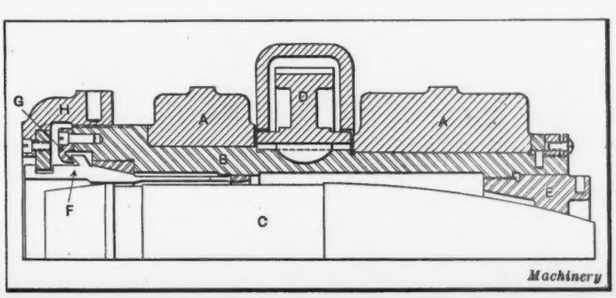


Fig. 3. Sectional View showing Method of holding Work in which Thread is to be milled

FAFNIR "DRAGON" TYPE BALL BEARING

The "Dragon" type constitutes the most recent development in ball bearings by the Fafnir Bearing Co., New Britain, Conn. In design, this new ball bearing differs radically in several respects from any other type of bearing, involving distinct advantages for certain conditions of service. Moreover, it has been thoroughly tested and has achieved success in the numerous instances where it has already been installed in actual service conditions of operation. Although the accompanying illustrations quite clearly show the salient and distinctive principles involved in the "Dragon" bearing, they may well be supplemented with a few words of description. To begin with, this is a double-row ball bearing manufactured in standard single-row widths, in each instance containing approximately double the number of balls of the corresponding single-row bearing. This very advantageous feature in the construction of the "Dragon" bearing is made possible by the fact that the two rows of balls are staggered in relation to one another. Furthermore, this intersecting of the two rows of balls renders superfluous the use of a ball retainer, since the balls automatically space one another and travel around the race paths with a total absence of spinning.

On account of the greater number of balls, the "Dragon" bearing will easily carry fully as much radial load as a single-row radial bearing. However, since it is an angular contact ball bearing in which the load lines of the two rows of balls are mutually opposed, the "Dragon" bearing will carry, in addition to the radial load, a heavy thrust load in either direction. The significance of this important feature of the bearing will be even more thoroughly appreciated by the reader when he realizes that in existing types of single-row angular contact ball bearings, thrust load can be carried in one direction only, resulting in a constantly present possibility that the bearing may be so mounted that the thrust load does not fall on the heavy side of the ring. A mistake of this kind in mounting would naturally result in the destruction of the bearing itself and, very likely, of other parts of the machine. In the "Dragon" bearing, how-

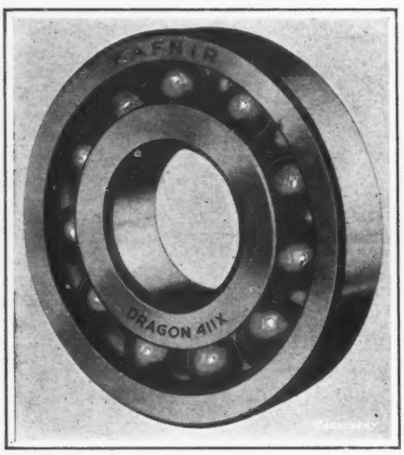


Fig. 1. "Dragon" Ball Bearing manufactured by Fafnir Bearing Co.

ever, it will be plainly seen that there is no possibility of such mishap, since the thrust capacity is equal in both directions. Furthermore, this bearing is a self-contained unit and does not require a second bearing mounted with its thrust line opposed, in which event the efficiency of the entire installation depends upon the accuracy with which an adjustment is made of the bearings endwise, in order to effect exactly the correct degree of ball contact, involving the elimination of end play without cramping the bearings. These are considerations of primary importance, especially at the present time, since in many plants the men in the assembly departments are not skilled mechanics, and no matter how complete the directions for mounting, costly mistakes will and do occur.

Coming to a discussion of the conditions under which the "Dragon" bearing is particularly applicable, it will be evident from the above statements that this is a ball bearing which in every instance is interchangeable with the corresponding standard single-row radial bearing, but which, in addition to possessing equal capacity for carrying radial loads, will take heavy end thrust loads in either direction. Consequently, it will frequently be found highly advantageous, and also economical, both in space and money, to install this type of bearing where it would have hitherto been customary to employ a single-row radial bearing and a thrust bearing. For example, under conditions of service involving extremely high speeds of rotation, the "Dragon" bearing will be found far more efficient than a combination of radial and thrust bearings. This is due to the fact that the effectiveness of a thrust ball bearing at very high speeds is seriously affected by the tendency of centrifugal force to cause each ball to travel on a tangent and leave the races. On the other hand, centrifugal force increases the efficiency of the "Dragon" bearing, since it causes the balls to be seated more firmly in the outer races. At this juncture, it should not be overlooked that this bearing may also be utilized in place of an ordinary two-row angular contact ball bearing performing the same work but occupying less space.

An ideal application in which the efficiency of the "Dragon" bearing may be fully utilized is to be had in a worm-shaft mounting, a typical example of which is shown in Fig. 2. Here the bearing carries the radial load at one end of the shaft and, in addition, takes the heavy end thrust involved in the transmission of power through the gears, alternating in direction, whenever the gears are shifted from forward to reverse drive and vice versa. This is but one of the numerous applications for which this bearing is adapted. Machine designers who have occasion to design bearings for carrying shafts on which there is a combination radial and thrust load, should find this bearing well adapted for their use.

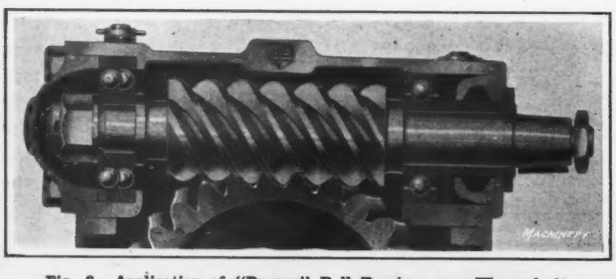
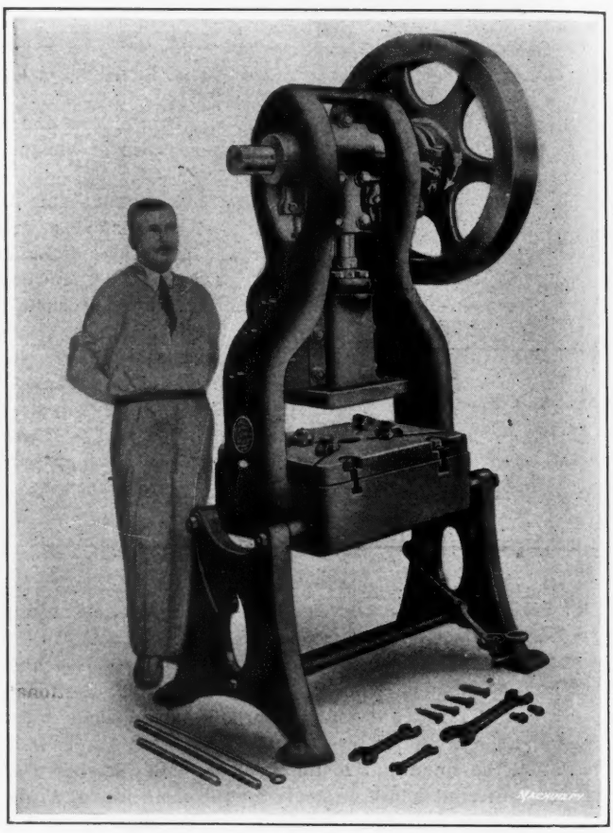


Fig. 2. Application of "Dragon" Ball Bearing on a Worm-shaft

FERRACUTE POWER PRESS

The illustration shows the third size in a series of six single-action presses recently designed by the Ferracute Machine Co., Bridgeton, N. J. These presses are adapted for cutting and forming sheet-metal work of large area, being particularly suitable for blanking and stamping coal-hod sections, petroleum can bodies, metallic shingles, etc. The frame is a single casting, and the arched columns are solid. The ram has a wide flange to adapt it for the use of large upper dies. This press is provided with a pin clutch, and the shaft boxes are convenient for adjustment or shaft removal. The front of the bed is pivoted to the legs, which enables the press to be inclined when desired, the dies remaining at approximately the same height from the floor, whether upright or inclined. Well rounded corners and large fillets are noticeable features.

Some of the dimensions of the press shown are as follows: Size of bed, right to left, 25 inches, and front to back, 22 inches; width between columns, 26 inches; size of flywheel, 35 inches diameter, 6 inches face; and weight, 750 pounds. The steel shaft has a diameter of 3½ inches at the journals and 4¼ inches at the crank; the stroke is 2 inches; and ram adjustment, 3 inches. The height from bed to ram at top of stroke and adjustment is 10 inches; and total weight of the press, about 3900 pounds.



Single-action Power Press built by Ferracute Machine Co.

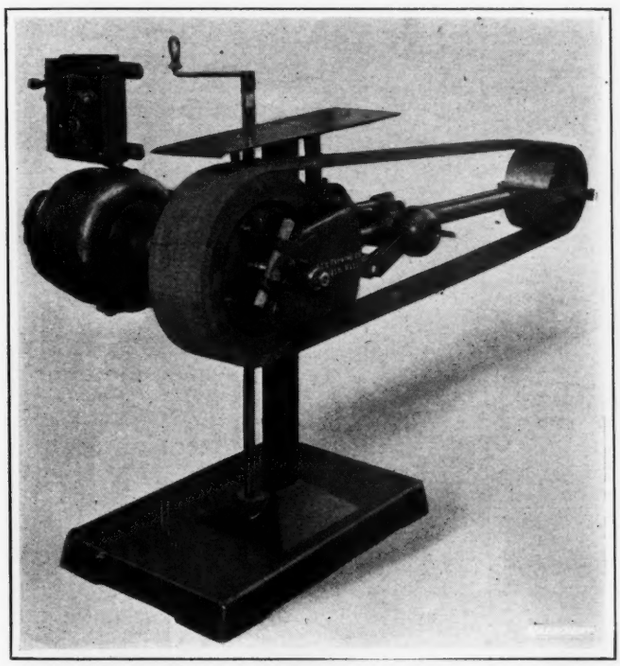
CHAIN FOR HANGING PIPE

To meet the conditions which must be fulfilled in hanging pipe, the Cleveland Galvanizing Works Co., E. Cooper Ave. and Pennsylvania Railroad, Cleveland, Ohio, has developed a special chain which is particularly adapted for this purpose. It is known as "Bull Dog" chain, and is secured to the ceiling by screw-hooks. The chain is furnished in reels, from which pieces of the desired length can be cut as required. A feature claimed for this method of hanging pipe is the rapidity with which the work of erection can be accomplished. In preparing a support for the pipe at any point, a screw-hook is placed in the ceiling or beam over the pipe, and a piece of chain cut to the desired length is wrapped around the pipe, after which opposite ends of the chain are slipped onto the end of the screw-hook. It is claimed that the flexibility of "Bull Dog"

chain enables it to be used in practically any location. In cases where there are temporary or unstable obstructions between the pipe and point of support, the chain can go around these, and if it is necessary to remove the obstruction later on, such a result can be easily accomplished, as there is no difficulty in taking up the slack in the supporting chain. The same is true in the case of taking down and putting up existing pipe lines, and adjustments in the level of the pipe can easily be made. "Bull Dog" chain is made of cold-drawn steel wire, and the links are formed with a special tie which cannot be pulled out. A galvanized finish adapts this chain for use on water pipes which are likely to "sweat," or in damp places where trouble might be experienced from rust or corrosion.

BLEVNEY MOTOR-DRIVEN WHEEL-TYPE CUSHION POLISHING MACHINE

The Blevney Machine Co., Greenfield, Mass., has brought out an improved type of motor-driven polishing machine, the special features of which are that the base has been increased to properly take care of the greater weight resting upon it due to the motor drive; a screw with a handle has also been



Motor-driven Wheel-type Cushion Polishing Machine built by Blevney Machine Co.

provided for raising and lowering the head; and the column supporting the machine upon the base has been made heavier on account of the increased weight of the machine. The raising and lowering screw passes through a bracket which serves as a nut for the screw, and this bracket, at the same time, supports the motor. In order to obtain a very accurate alignment of the motor shaft to the wheel shaft, the legs of the motor housing have been cut off and the housing has been turned concentric with the pulley bearing, this being considered the only way in which it was feasible to obtain an accurate alignment. A jaw clutch is interposed between the motor and the pulley, this clutch being so arranged that the wheel may be removed without disturbing the drive. The operating switch is mounted in a handy position for the operator, on the top of the motor. In other respects, the machine is identical with the Type B machine illustrated in the October, 1917, number of MACHINERY. This machine is very convenient for use in shops that are equipped for direct motor drive.

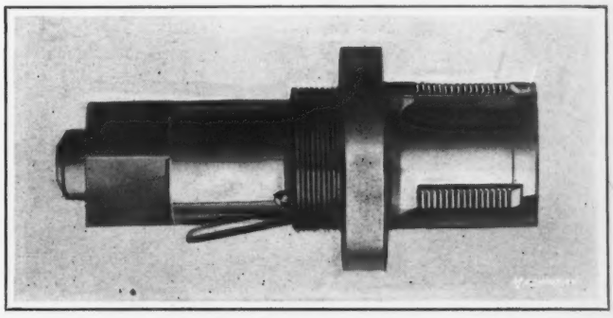
M. B. HILL PRODUCTION DRILL JIG

For use in the performance of production drilling operations, the M. B. Hill Mfg. Co., 6 Eden St., Worcester, Mass., has recently developed a drill jig which is shown in the illustration which accompanies this description. It will be apparent from the illustration that this jig is adapted for rapidly drilling cylindrical work of various sizes which may be located in the V-block below the drill bushing and located endwise by means of the adjustable end-stop. By having the jig open on one side, provision is made for rapidly brushing out chips. The knurled screw at the top of the jig is simply provided to hold the work in place until the drill comes into engagement. A jig of this kind can be arranged for drilling holes in balls. The base is 2 by 4 inches, the capacity is for work up to 1¼ inch in diameter, and the jig weighs 3 pounds.

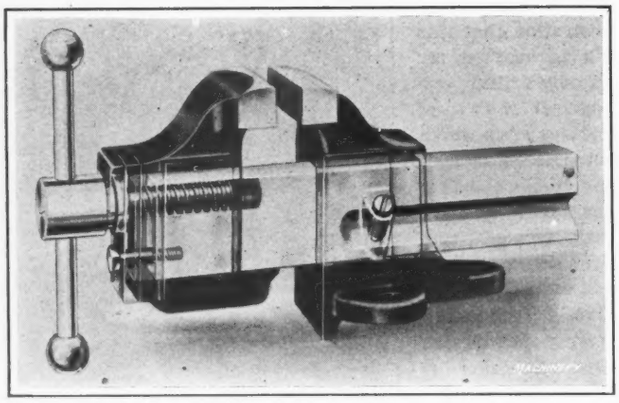
Production Drill Jig made by M. B. Hill Mfg. Co.

VICTOR ADJUSTABLE AND COLLAPSIBLE HAND SIZING TAPS

In threading the nose of shells most ammunition manufacturers have found it necessary to use a hand sizing tap to secure accurate and perfect threads. A solid adjustable tap having either four or six renewable high-speed chasers is generally used for this work. As the tap is adjustable either over or under size, excellent threads can be obtained; and by grinding the chasers their life can be extended considerably, after which they can be renewed at a smaller cost than that of a new solid tap. However, this solid adjustable tap must be backed out, the same as an ordinary tap, and shell manufacturers all agree that in starting to back out a tap the first few threads are sometimes spoiled, so that a great deal of time and effort may have to be expended to procure satisfactory threads. This difficulty has been overcome by a collapsible hand sizing tap, designed and manufactured by the Victor Tool Co., Waynesboro, Pa. The accompanying illustration shows this tap, the construction of which is similar to the standard collapsible tap manufactured by this firm, except that instead of the collapsing feature being automatic, the chasers are collapsed by merely pressing the trigger when the desired depth is reached. This releases the latch which permits a tension spring in the body of the tap to withdraw the plunger, so that the chasers sliding along a taper point on this plunger are positively collapsed. The chasers bear their full length on the plunger and slide along a tongue milled thereon. An adjustable ring gages the depth of the thread desired. Size adjustment is effected from either end desired and can be absolutely maintained. The taps are also furnished with a pilot if desired. They have already been thoroughly tried by several large munition plants and are pronounced very satisfactory. These taps are made in any size from 1½ inch up.



Adjustable and Collapsible Hand Sizing Tap made by Victor Tool Co.



Quick-action Vise made by Velox Vise Co., Inc.

VELOX HIGH-SPEED VISE

In developing the vise which is here illustrated and described, the purpose of the Velox Vise Co., Inc., Lowville, N. Y., has been to provide an equipment which is adapted for general bench work and which is capable of operation with the minimum loss of time. Another feature is that the movable jaw of the vise is carried on a solid steel bar which provides ample strength and durability. The method of operation is as follows: To open the vise, the operator places his hand under the screw-head and lifts the screw sufficiently so that the movable jaw may be pulled forward to provide the required opening to receive the work.

After the work has been placed between the jaws, the movable jaw is raised and pushed into contact with the work, after which the screw is tightened to secure the work in place. When an operation has been completed on a piece held between the jaws, loosening is accomplished by first giving the screw a partial turn. Particular attention is called to the fact that the screw is employed only for tightening and releasing the jaws, and a partial turn is sufficient for this purpose. Vises of this type are made in different styles and sizes to meet the requirements of various classes of work. They are made with either a stationary or a swivel base, steel bars, and cast-steel faced jaws, with capacities of 4, 4½, 5, 6, 7, 8, 9, 10, and 11 inches between the jaws. Other styles of vises will be placed on the market at an early date.

PASCHALL LATHE ATTACHMENT

To meet the requirements of garages, jobbing shops and other places where a variety of machine work has to be accomplished with a somewhat limited mechanical equipment, the Paschall Tool Co., 510 Long Beach Bank Bldg., Long Beach, Cal., has developed a lathe attachment which is shown in Fig. 1. This attachment is especially adapted for such work as axle squaring, keyway cutting, slotting, grooving, and similar operations. The attachment is universal in that it may be attached to any lathe furnished with a compound rest, and its use is said to be as simple as that of the toolpost attachment. Only a few moments are required for setting up, and it is unnecessary to remove any portion of the lathe to provide for the employment of this attachment.

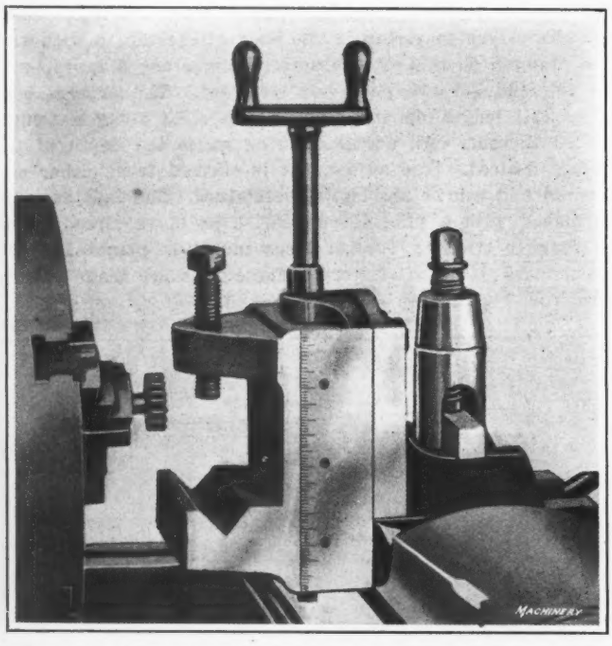


Fig. 1. Paschall Lathe Attachment for Use in performing Milling and Boring Operations

Particular care has been taken to provide a perfect bearing for this attachment on the lathe, and on this account chatter and vibration have been practically eliminated. A bearing is provided on both the side and top of the compound rest. When the Paschall attachment is used on a lathe, all of the automatic feeds may be employed, the only hand operation being the manipulation of the vertical feed-screw. Both a taper and a depth gage are provided on the attachment, and cutters of any type may be used in practically the same way as with a milling machine. For instance, cutters may be carried in a chuck, in a collet, or on an arbor between centers. As a result, it is possible to cut tapered keyways or slots. The attachment is also well adapted for carrying a boring-bar.

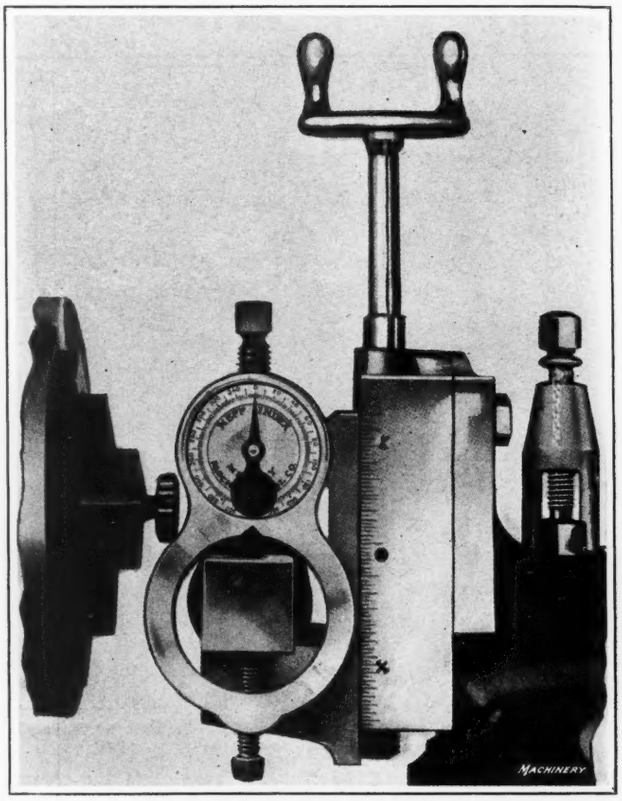


Fig. 2. "Neff" Index developed for Use in Connection with Paschall Lathe Attachment

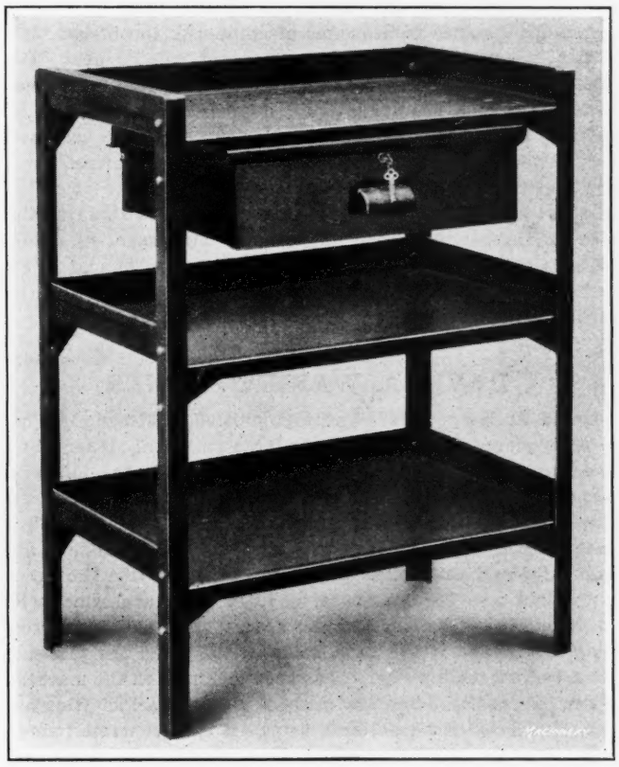
To simplify the work of laying out parts to be handled in the Paschall attachment, the "Neff" index was developed, and this device is shown in operation in Fig. 2. It fills the same position on the shaper, drilling machine, lathe or planer, equipped with the Paschall milling attachment, that the index head does on a standard milling machine. It is particularly adapted for cutting squares, hexagons, octagons, etc., for lining up or offsetting keyways, for lining up or offsetting drilling machine work, and for a great variety of other operations which will suggest themselves to any experienced mechanic. The "Neff" index is made in two sizes known as Nos. 1 and 2, which are adapted for use in connection with pieces up to 2½ inches and 4 inches in diameter, respectively.

NEW BRITAIN ALL-STEEL WORK-STAND

The field of the work-stand has become so varied and its use so general as to render a definition of its purposes almost

superfluous. Work-stands made by the New Britain Machine Co., New Britain, Conn., are made of steel throughout, their construction affording ample strength with minimum weight—stability and durability without clumsiness. Two legs at each end are formed by a single steel angle, with a continuation across the top that adds both rigidity to the construction and a finish to the appearance of the rack. The trays are of such material and design as to render them remarkably stiff and substantial. The strengthening influence of the two-inch flange along the sides and back is supplemented by a formed hem, which also supplies a smooth finish to the edge of the tray. The forward edge is turned down to afford convenient access to the trays and facilitate cleaning them. At the corners there are welded gussets by which the trays are bolted to the uprights and given additional support. The stand has no sharp corners or ragged edges by which accidental injury might be sustained.

Stands of this type may be had with two or three trays and with or without a drawer. The height to the top tray is 32 inches, and the size of the trays is 16 by 26 inches. A hem of triple thickness around its upper edge and the welding of



All-steel Work-stand made by New Britain Machine Co.

all joints combine to produce a drawer of remarkable strength and rigidity. The slide ways are welded to the under side of the top tray and give to the drawer a smooth movement free from all binding or cramping tendency. By having the drawer handle of generous size with a shape of special design, a very comfortable hand-hold is obtained. A cylinder lock of good grade, with two individual keys, is provided, and master keying, if desired, may be had at cost. The possession of a master key by the foreman will prevent the stowing of contraband in drawers. These stands are shipped knocked down and may be most easily and quickly assembled as follows: Insert bolts in one side angle and lay it flat on the floor or on a box. Place the trays on edge in the proper positions and add nuts. Apply the other side angle to the upper edges of trays and insert the bolts. Then stand the tray upright and tighten all the bolts.

EASTERN TUBE & TOOL CO.'S DRILL CHUCK

One of the recent products of the Eastern Tube & Tool Co., Inc., 41-59 Gardner Ave., Brooklyn, N. Y., is the semi-automatic

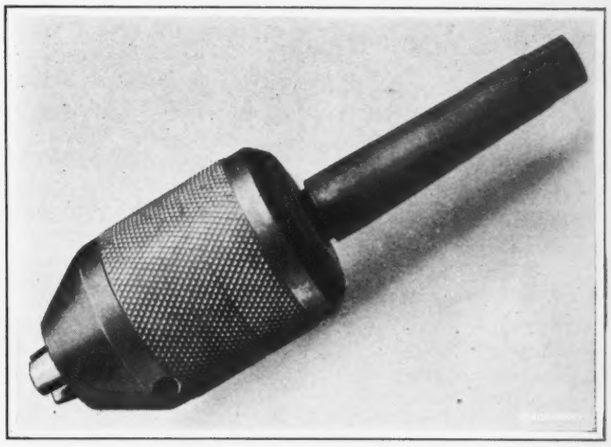


Fig. 1. Semi-automatic Drill Chuck made by Eastern Tube & Tool Co., Inc.

drill chuck which is shown in Fig. 1. Probably a better idea of the way in which this chuck operates will be gathered by referring to Fig. 2 which shows the parts of this chuck. Here it will be seen that the jaws *A* are threaded to engage a threaded operating cone *B* which expands or contracts the jaws as required. In order to avoid frictional resistance, a special form of ball bearing *C* is provided above the flange on the shank *D*, and this ball bearing supports the weight of the chuck body *E* so that it can rotate freely. Beneath the flange there is a pressed steel washer or buffer *F*, the purpose of which is to receive the thrust when the jaws are raised to their highest position, that is, when they are expanded as far as possible. This buffer prevents binding the threaded cone with the threads on the jaws and causing the chuck to stick. The threads are of the 30-degree buttress type which afford ample strength.

Two important features of the design of this chuck are the provision made for preventing the jaws from tilting in the body, and the adequate means provided for excluding dust and other foreign matter from the mechanism. The jaws are formed with keys which enter grooves in the chuck body so that the jaws are constrained to travel in a straight line and cannot be tilted out of alignment owing to the torque of the drill. As regards the exclusion of dirt, attention is called to the fact that beneath the threaded operating cone there is a pilot *G* which is a close fit in the central hole *H* at the bottom of the chuck body. The jaws also fit snugly in the recesses in which they slide so that there is no open space through

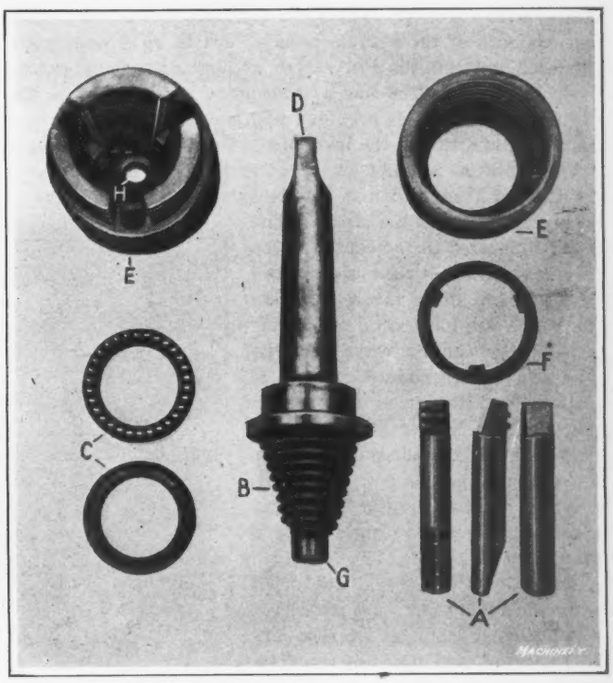
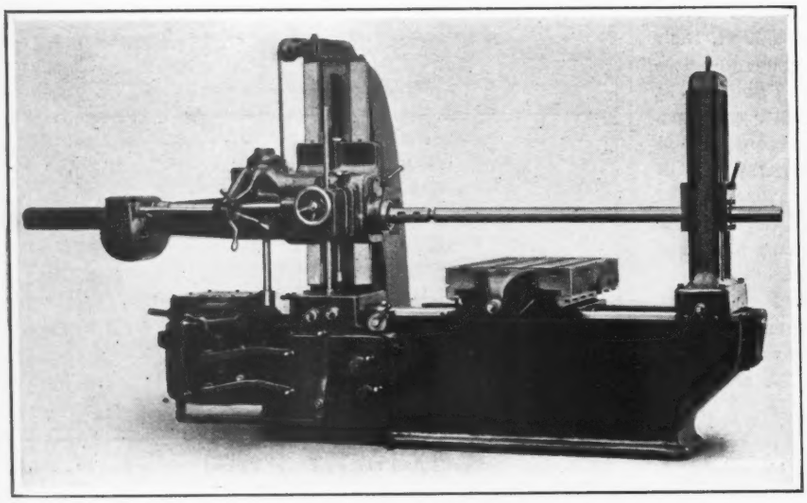


Fig. 2. Parts of Semi-automatic Drill Chuck shown in Fig. 1



No. 5 Horizontal Boring, Milling, Drilling, and Tapping Machine built by Defiance Machine Works

which dirt can find its way in to clog the threads and prevent the chuck operating freely. It will be seen that the chuck body is made in two parts which are threaded together, and after assembling, the body of the chuck is knurled so that the two parts are secured together in a way which makes them essentially a single piece. Holes are drilled in the body to provide for the use of a pin in the event of the chuck binding, thus making it an easy matter to release the chuck and free the drill which is held in it.

DEFIANCE BORING, MILLING, DRILLING, AND TAPPING MACHINE

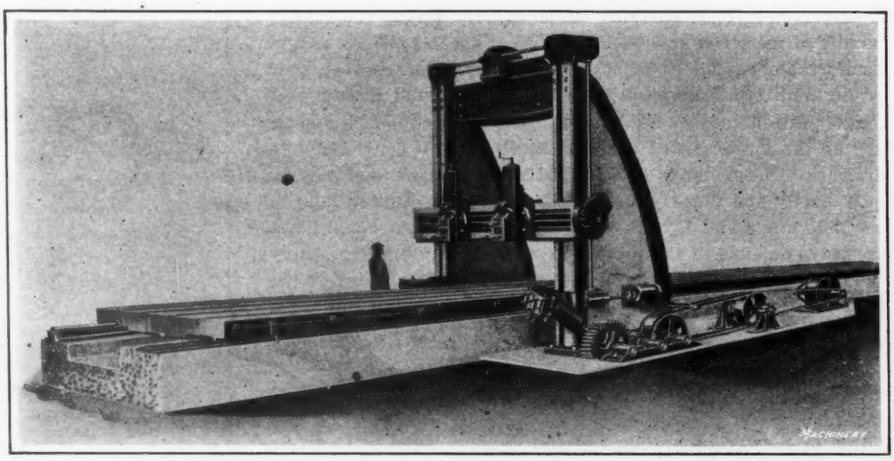
In the May number of MACHINERY mention was made of a horizontal boring, milling, drilling, and tapping machine which had just been placed on the market at that time by the Defiance Machine Works, Defiance, Ohio. The machine described in May was a No. 6 size, and to meet the requirements of shops having work for which this machine is not entirely adapted, a No. 5 horizontal boring, milling, drilling, and tapping machine has now been brought out, which is of quite similar design. It is made to meet every requirement of machine tool users where intensive production and precision work are factors of importance. Great care has been taken to eliminate all possible complications of design and to make all adjustments readily accessible. All moving parts of the mechanism have been carefully guarded to provide for the safety of the operator. The speed mechanism, feed mechanism, and contents of the spindle housing are of unit construction, and each unit affords full access without disturbing parts of other units. The bed has a three-point bearing on the floor, so that the machine is provided with a firm foundation regardless of inequalities in the level of the floor on which it is placed.

A substantial bearing on the column has been provided for the spindle head, which is counterbalanced to relieve the elevating screw of undue strain. The screw is located in the center of the column ways between a dovetail guiding edge and a tapered take-up gib which are located on the inside edge of the column ways. At the rear end of the slide, clearance is allowed, and the front end is provided with a binder gib. This arrangement brings the guiding edge, as well as the clamping surface, close up to the spindle nose and work, which effects a rigid support for the cutting tool. The feeds are selected by two levers, operating two cones of gears, by means of which twelve changes of feed are obtained for each speed of the spindle. The back-gears do not influence the feed mechanism, thus avoiding the possibility of confusion in selecting feeds. A lever is used in connection with a simple index to apply the feed for different purposes as occasion demands; feed movements are available for moving the spindle, spindle head and tail-block in a vertical direction, for moving the platen along the saddle, or for moving the saddle along the bed. The spindle head, platen, and saddle are also provided with hand feed movements, and dials graduated to 0.001 inch facilitate making accurate settings. An interlocking arrangement for the feed control lever and fast traverse lever enable these two levers to be located close together without danger that the two movements will be engaged simultaneously.

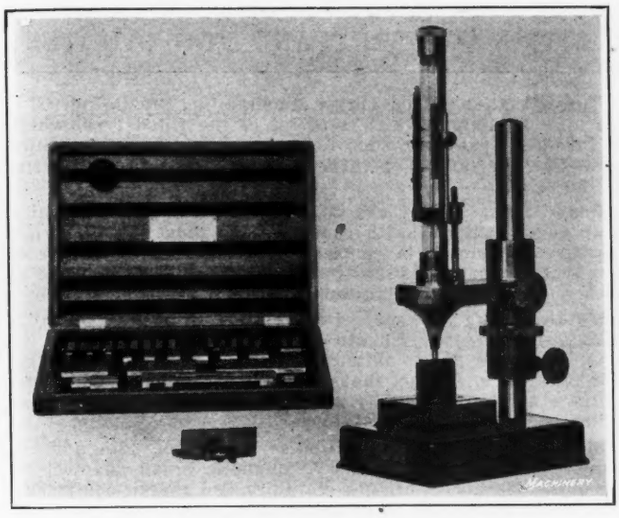
The principal dimensions of the machine are as follows: Morse taper in spindle, No. 5; diameter of spindle, 3 inches; travel of spindle, 24 inches; maximum distance from face of spindle sleeve to face of tailstock, 5 feet; maximum distance from center of spindle to top of platen, 25 inches; maximum distance from center of spindle to top of bed, 33½ inches; maximum vertical adjustment of spindle head, 24½ inches; number of available speed changes, 10; range of speeds, 15 to 336 revolutions per minute; number of feed changes for spindle, spindle head, saddle or platen, 12; range of feeds per spindle revolution, 0.003 to 0.375 inch; dimensions of boring-bar, 3 by 68 inches; size of working surface of platen, 24 by 48 inches; maximum cross-feed of platen with adjustable stop, 40 inches; maximum longitudinal adjustment of saddle, 36 inches; and distance from top of bed to top of platen, 8½ inches. Machines of this type are equipped for belt drive or for individual motor drive.

DAVID A. WRIGHT PLANER

David A. Wright, 568 Washington Blvd., Chicago, Ill., has recently placed on the market the large universal planer which is shown in the illustration which accompanies the following description. The method of construction is, briefly, as follows: The frame of the side housings is made of three cast-iron parts, namely, a front, back, and base, which are finished and assembled and then filled with concrete to provide the necessary rigidity. The platen is made of structural steel with cast-iron T-slots set in, and the spaces filled with reinforced concrete. When it has been made in this way, the platen is planed off on the top after it has been mounted on the machine. The ways consist of one way made of ground steel shafting and one flat way of cast iron, each being set on a concrete foundation. Planers of this type may be equipped with three individual motors or with a reversing motor, and they are provided with pneumatic feed. The range of sizes runs from 6 to 20 feet, with any length of bed required to handle work for which the machine is to be used.



Planer built by David A. Wright in which Concrete is used in constructing Housings, Platen, and Bed



Precision Fluid Gage made by Coats Machinery Co.

COATS PRECISION FLUID GAGE

The Coats Machinery Co., Land Title Bldg., Philadelphia, Pa., is now manufacturing a precision fluid gage which forms the subject of the following description. This gage is equipped with an angle-plate or anvil mounted on a base 3 by 3 inches in size, which is made of tool steel and hardened. An adjustable stop slides in two grooves and is always maintained at right angles to the plate. This stop simplifies the inspection of such work as piston-pins, because it enables the operator to adjust his stop in order to strike the maximum diameter of the pin without experimenting and without looking for it; also, the work is always held in the proper position. This gage has a capacity for handling round work ranging from ¼ to 6½ inches in diameter, and a special plunger, with a needle point and suitable anvil is provided for ball inspection. A special fixture for testing the grooves of annular ball bearing races may be furnished to order.

Provision is made for securing independent coarse or fine adjustment on the column, an independent rack and pinion being employed to secure coarse adjustment and an indexed adjusting nut for fine adjustment. The thread engaging the adjustable supporting arm is 40-pitch, left-hand, and the thread engaging the sleeve which is clamped to the column for fine adjustment is 40-pitch, right-hand, so that the arrangement gives an effective pitch of twenty threads per inch. The ratio of the diaphragm area to the area of the bore in the glass tube is approximately 50 to 1, with the result that each turn of the adjusting nut, which is indexed into fifty divisions, gives approximately 20 by 50 or 0.001 inch per turn. As the instrument is, however, primarily a comparator and not a measuring machine, this point is of no great importance.

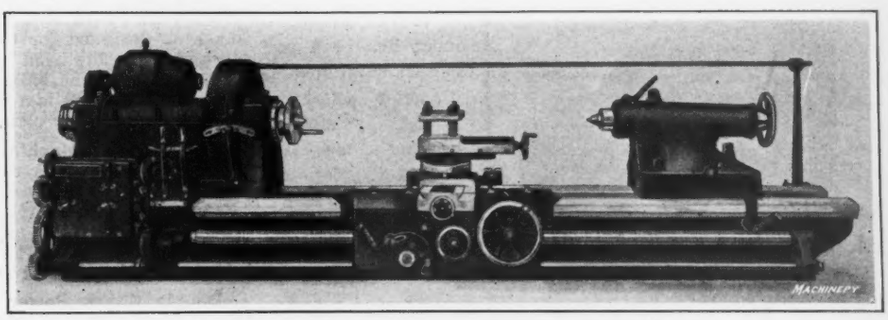
A liberally proportioned bearing surface has been provided on the 1-inch column for the arm supporting the fluid container, and it will be apparent from the illustration that a bearing is provided above and below the adjustable supporting arm, which effectually prevents spring. The adjustable supporting arm, the indexed adjusting nut, and the clamping nut, move in union up and down the column, sliding in the same keyway for coarse adjustment by means of a rack and pinion. In using the gage, the testing head is lowered sufficiently to almost touch the master pin, ball, or standard gage-block, after which the clamping nut is tightened and fine adjustment is obtained by turning the adjusting nut toward the inspector. The pointers are set in accordance with standard practice in the use of gages of this type; that is, one for the normal liquid level, one for the minus limit which is allowed on dimensions of the work, and one for the plus limit. Reference to the illustration will show the nut and screw arrangement for collective adjustment of the pointers, the metal protecting tube serving as a guide for the holder carrying the pointer rod and scale. Magnification varies from 800 to 1250, the standard being 1000; that is, a scale 2 inches long with twenty 0.0001-inch graduations, or a range of from + 0.001 inch to — 0.001 inch.

A detachable slanting base, which is not shown in the illustration, is furnished as a standard part of the equipment and permits the use of the instrument in either an upright position, as illustrated, or tilted backward without the necessity of removing the gage from the column. For thread gage testing by the three-wire system, a perfectly flat calipering end is required for the plunger and special provision is made for handling such work. The manufacturers of this gage call particular attention to the coned plunger guide which prevents side drag on the diaphragm. The fluid container is made of brass, and the coned plunger guide, which screws into the arm, holds the container in position. The plunger slides freely in the bearing formed by the lower part of the plunger guide, and is pinned to prevent it from rotating. A coned plunger guide with a detachable steel nose may be furnished, making different calipered plungers readily exchangeable from below without requiring the plunger guide to be removed.

Glass tubes may be furnished with either a beaded open bulb, a closed bulb, or a closed bulb with one hole provided at the side. A flexible rubber cap may be slipped over the bead of the open bulb to reduce evaporation. There is no evaporation with the closed bulb, but tubes with bulbs of this type are more difficult to fill; this limitation is partially offset by the fact that such tubes only have to be filled once. The base of the gage measures 7½ by 5¼ inches, and a special large surface plate can be furnished if desired. The height of the column carrying the adjustable testing head is 12 inches, and the total height of the gage with the testing head in its uppermost position is 19½ inches. Sixteen pounds is the approximate weight of the gage without the detachable slanting base, and with this base the gage weighs approximately 18 pounds.

NIELSEN & WINTHER LATHE

Nielsen & Winther, Ltd., 59-61 Pearl St., New York City, are now placing on the market heavy-duty engine lathes of the type here illustrated. These machines, which are built in Copenhagen, Denmark, are now being shipped to this country. Great care has been taken in the selection of materials best adapted for the conditions of service, and the principal parts of the lathe are machined in jigs and fixtures making them interchangeable. To withstand the severe strains to which a heavy-duty lathe of this type is subjected, the bed is liberally proportioned and braced by webs for its entire length. The spindle is made of steel and supported in adjustable phosphor-bronze bearings; a hole is bored through its entire length and the outside surface is finished to size by grinding. The speed-box is secured to the back of the bed and changes of spindle speed are obtained in the headstock by means of a friction coupling and sliding gear mechanism. Individual motor drive is employed. The feed-box, which is located at



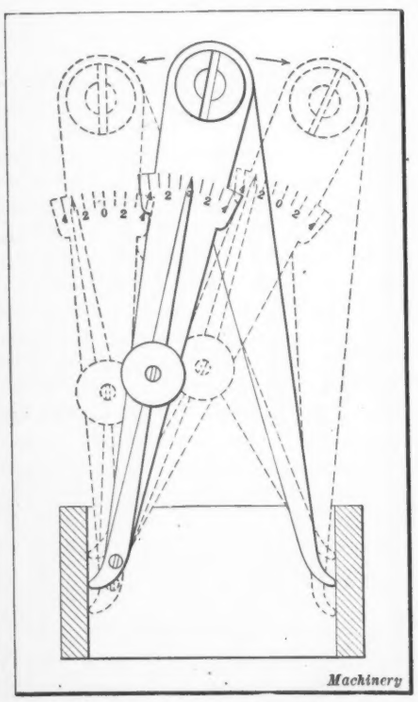
Heavy-duty Engine Lathe built by Nielsen & Winther, Ltd.

the front of the bed, provides eight changes of speed for the feed-shaft, as well as thirteen different threads which may be cut by means of the lead-screw and change-gears.

The carriage is ordinarily provided with a common tool-rest, but it may also be furnished with a square or hexagonal turret as special equipment. A thread-chasing dial is provided, enabling the carriage to be quickly withdrawn by hand instead of having to return it by power feed. Cross and longitudinal motions of the carriage are interlocked so that it is impossible for both to be engaged simultaneously. The cross-slide can be set at any desired angle, graduations being provided for the purpose of facilitating accurate setting. The tailstock is heavily constructed and provision is made for setting it over for the performance of taper turning operations. A positive locking device holds the tailstock in any desired position. Longitudinal traverse of the tailstock along the bed is accomplished by means of a rack and pinion. The principal dimensions of this machine are as follows: Height of tailstock, 23 inches; maximum swing over bed, 46½ inches; maximum swing over carriage, 33½ inches; length of work which can be turned on machine with 20-foot bed, 9 feet, 10 inches; width of bed, 34½ inches; diameter of spindle in front bearing, 8 inches; diameter of spindle in rear bearing, 7½ inches; diameter of hole through spindle, 4⅝ inches; number of spindle speeds, 8; range of spindle speeds, 5 to 120 revolutions per minute; range of feeds per spindle revolution, 0.010 to 0.375 inch per revolution; number of threads cut by seven available change-gears, 13; range for thread cutting, 1 to 10 per inch; horsepower required to drive machine, 20; and net weight of machine, approximately 20,000 pounds. Lathes of this type may be equipped with a special form of spindle to adapt them for use in factories engaged in shell manufacture.

GROVE INDICATING GAGE

In developing the indicating gage which is here illustrated and described, it was the object of the Grove Mfg. Co., Dayton, Ohio, to provide a tool for accurately measuring a considerable range of work which is often inaccurately scaled. It will be apparent from the illustration that this gage has some of the features of a pair of calipers, although the method of use is rather different. For instance, in obtaining the diameter of a hole, the gage is first set with a micrometer by tapping against the solid leg as in the case of an ordinary pair of calipers, and particular attention is paid to where the indicator registers when at its smallest points. The gage is then tried in the hole or slot, using only the movement shown by the arrows, and if it registers the same as for the micrometer, assurance is obtained that an accurate measurement has been secured for the inside diameter of the work by simply reading the micrometer. Zero is used as the reference point in the illustration, but in practice any line on the graduated arc can be employed with equally good results. This gage is made with hardened steel points and carefully fitted joints, so that it is practically indestructible under average conditions of service.



Indicating Gage made by Grove Mfg. Co.

NEW MACHINERY AND TOOLS NOTES

Turret Lathe: Wood Turret Machine Co., Brazil, Ind. This machine is equipped with a turret of the tilted type, which is furnished with six sides for holding various tools. Stop-screws for the various operating positions project from the end of the slide.

Snap Gages: J. M. Clark Co., Bridgeport, Conn. Adjustable snap gages equipped with square-headed plugs which permit measurements to be taken close up to a shoulder. Gages of this type are made in sizes overlapping each other from 0 to 12 inches, and there are eighteen gages in the entire set.

Metal Melting Furnace: Hausfeld Co., Harrison, Ohio. A tilting, non-crucible furnace which has a capacity of 400 pounds. Either gas or oil may be employed as fuel, and attention is called to the fact that the change from one kind of fuel to the other can be rapidly made when occasion arises for so doing.

Magnetic Brake: Cutler-Hammer Mfg. Co., 12th and St. Paul Ave., Milwaukee, Wis. A magnetic brake adapted for use on cranes, hoists, bridges, elevators, and similar equipment. This brake is claimed to be designed in such a way that it is especially adapted for use in places where quiet operation is required.

Anti-scale Compound: Coats Machinery Co., Land Title Bldg., Philadelphia, Pa. An anti-scale compound for use in hardening high-speed steel. This compound is claimed to have no other action on the steel except to prevent oxygen and acid gases of the furnace from coming into contact with the heated steel and causing it to scale.

Tool and Cutter Grinding Machine: Coates-Kendall Corporation, 50 Church St., New York City. A universal tool and cutter grinding machine which is known as a No. 6 and is adapted for all sorts of tool and cutter grinding. The machine may also be used to advantage for the performance of grinding operations involved in making jigs and fixtures.

Electric Hoist: Yale & Towne Mfg. Co., 9 E. 40th St., New York City. An electrically driven hoist adapted for handling loads ranging from ½ to 5 tons. Means are provided for easily controlling the hoist, and it can be suspended from a fixed point, shear pole, jib crane, trolley running on an overhead track, or from a traveling crane as required.

Turret Tailstock: Jones Superior Machine Co., 1258-1272 W. North Ave., Chicago, Ill. The design of this tailstock adapts it for use on engine lathes where it is required to perform a number of operations in sequence, without changing the setting of the work. The turret is rotated by hand, but is automatically indexed in order to bring each tool into accurate alignment with the headstock.

Shell-nosing Presses: Southwark Foundry & Machine Co., Washington Ave. and 5th St., Philadelphia, Pa. These presses have a capacity for nosing 75-millimeter shells at the rate of three per minute when operating under a line pressure of 1200 pounds. A balanced three-way valve is provided on the press which enables it to operate easily. These machines are adapted for continuous operation.

Rotary Hacksaw: Barnes & Irving, Inc., Syracuse, N. Y. A device known as the "Misener" rotary hacksaw which is intended for cutting round holes through thin sheet metal or for other purposes of a similar nature. A square tapered shank may be provided on the saw to fit into an ordinary bit stock. If so desired, a round tapered shank may be provided or a straight shank for use in a drill chuck.

Electric Furnace Control: General Electric Co., Schenectady, N. Y. A system of automatic control to handle the motive power required on electric furnaces having a standard maximum capacity of from 20 to 30 tons. This control panel is made in three sections and affords refinement in the controlling devices made necessary by the increased steel production required of the electric furnaces.

Deck-plate Scarf Milling Machine: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. A milling machine designed for the purpose of machining the scarf on deck-plates. The head is equipped with a geared feed in both directions and the spindle saddle has cross hand adjustment on the rail. There is a finished surface on the base that serves as a work-table for clamping the plate which is to be milled.

Roll Grinding Machine: Detroit Tool Co., 1487 St. Antoine St., Detroit, Mich. A roll grinding machine which is adapted for finishing cylindrical pieces ranging from ¼ to 1 inch in diameter. Work handled on this machine must be straight, and there must be no larger portions than the part which it is required to grind. The work is mounted in a guide block, along which it is slid into contact with the grinding wheel.

Double Crank Power Press: E. W. Bliss Co., Brooklyn, N. Y. The feature of interest about this press is its exceptional size which will be gathered from the following dimensions: Width between uprights, 150 inches; width between gibs, 141 inches; depth of opening in bed, 36 inches; width of opening

in bed, 120 inches; maximum stroke of slide, 24 inches; adjustment of slide, 6 inches; and complete weight, 400,000 pounds.

Fuel Oil Burner: W. S. Ray Mfg. Co., 220 Market St., San Francisco, Cal. A fuel oil burner employing a method of atomizing the fuel in an open cup which is mounted in a horizontal position and revolved at the rate of 3450 revolutions per minute by an enclosed motor. Air traveling at high velocity is forced around the cup, in a direction away from it, thus introducing the fuel and air required for combustion into the fire-box.

Portable Crane: Canton Foundry & Machine Co., Canton, Ohio. A portable crane designed for the use of manufacturing plants in loading product and unloading raw material from railroad freight cars. For this service a crane is required that can be handled with safety by unskilled labor, and one that will stand all kinds of weather conditions. This new Canton crane has a capacity for handling loads of two tons and weighs 740 pounds.

Forcing Press: Atlas Press Co., 323 N. Park St., Kalamazoo, Mich. A forcing press adapted for operation by hand and power, which is made in several different sizes. The jaws are adjustable and the screw that carries the ram may be run up or down rapidly by a handwheel to obtain the desired setting, after which power is applied by drawing down a lever and engaging a catch. A safety device prevents breakage in case the operator forgets to shut off the power.

Fifth Wheel Trailer Control: Borst Coupler Control Mfg. Co., Buffalo, N. Y. This device is intended to increase the use of tractors and semi-trailers in the field of industrial transportation. It consists of a combination controlling and coupling mechanism which enables the driver to control the semi-trailer while backing into any position, without the necessity of leaving his seat. A carrier brake is employed in connection with the coupler control, to hold the trailer at the proper height for the tractor unit to back in and couple to it.

Plate Joggling Press: Southwark Foundry & Machine Co., Washington Ave. and 5th St., Philadelphia, Pa. A plate joggling press for use in shipyards. In addition to its application in this service, the machine is adapted for use as a manhole punch. The equipment of the machine includes special dies consisting of a main lower die section and an upper pressure die which is fastened to the ram. The lower die is cut away to permit steel sections to be passed through the machine at right angles to the horizontal center line.

Shell-sawing Fixture: W. Robertson Machine & Foundry Co., Buffalo, N. Y. A fixture designed for use on the No. 6 "Economy" hacksaw machines of this company's manufacture to adapt them for cutting 6-inch shells lengthwise through the center. Such a cutting operation is performed on a specified number of shells during the process of inspection. The fixture consists of a holder with tapered jaws which enter the flange on the large end, and clamps which engage the small end. This method of holding tends to open the shell while it is being cut.

Loading and Shipping Deck: Carbo Steel Products Co., Chicago Heights, Ill. This deck was developed to enable freight cars to be utilized to their full capacity for the transportation of such manufactured products as automobiles, motor trucks, and tractors. It is built of structural steel members, and attention is called to the fact that this deck can be used either in connection with box or flat cars, with the result that their carrying capacity is increased from 60 to 100 per cent. This result is made possible by enabling the load to be double-decked in the cars.

* * *

A WOMAN-SIZE LATHE

The pitfalls that await the advertiser who, without previous knowledge, rushes boldly into the mechanical field are illustrated by the following extract from an advertisement of a popular periodical; this announcement is devoted to more or less accurate details of industrial work now performed by women and to other work that they might do with some trifling changes such as that mentioned:

FACTORIES MADE OVER TO FIT WOMEN

But the great lathes? Could a woman turn them? Just make her a lighter one, a "woman-size" lathe, and she'll turn it faster than ever a man turned his!

* * *

The standardization of cargo trucks and passenger cars for the use of the Army has been completed. More than 75,000 standardized trucks and passenger cars have been ordered. Four types of trucks and three types of passenger cars have been selected as suitable for the various requirements of all the branches of the national service that have need for motor transportation.

NEW BOOK ON MECHANISMS AND MECHANICAL MOVEMENTS

MECHANISMS AND MECHANICAL MOVEMENTS. By Franklin D. Jones. 310 pages, 6 by 9 inches; 164 illustrations. Published by the Industrial Press, 148 Lafayette St., New York City.

In this book the author has presented a treatise on different types of mechanisms and on the various methods of transmitting, controlling, and modifying motion for securing changes of velocity, direction, and duration or time of action. Owing to the lack of a comprehensive work of this kind, modern and up-to-date in its treatment, it is believed that the present book will meet the very definite demand. It is intended especially for designers of machinery and for those interested in originating new mechanical devices, or in developing and perfecting those now in use. The purpose of the treatise is not only to explain how various mechanical motions may be produced and controlled, but also to show the relation between the theoretical and practical sides of the subject. Many examples of mechanisms are included, showing ingenious mechanical combinations, all of which are practical designs, and which not only illustrate the principles involved, but indicate exactly how those principles are applied.

In view of the fact that there is an almost endless variety of mechanisms, it would seem at first as if it were impracticable to deal with so broad a subject in a single volume of this size; but as the classes of mechanisms which differ radically in principle are few in comparison with those which simply vary in form, it has been found not only practicable, but—as a study of the book will prove—very desirable to have in one volume a variety of mechanical devices representing different types of mechanisms, selected especially to illustrate fundamental principles.

The book will be particularly valuable to engineering students, technical graduates, and draftsmen who understand the proportioning of parts to safely withstand stresses, and are generally proficient in theoretical mechanics, but who do not, as a rule, thoroughly understand the use of different combinations of parts for transmitting, reversing, or otherwise modifying motion to secure whatever action or effect may be required. Knowledge of this kind is imparted in the volume under consideration, and as the mechanisms have been classified and arranged so that various modifications of the same general type may be readily compared, the book is especially useful both as a reference book and as a text-book.

As already indicated, the different mechanisms are classified, and the book is therefore divided into ten chapters, dealing with the following subjects: Motion and General Methods of Transmission in Machines; Speed-changing and Controlling Mechanisms; Conversion of Rotary and Rectilinear Motions; Reversing Mechanisms; Quick-return Motions; Intermittent Movements; Irregular Motions; Differential Motions; Clutches and Tripping Mechanisms; and Automatic Feeding Mechanisms.

While dealing very comprehensively with the subject, and describing many intricate and complex mechanisms, the treatment in general is so clear and simple, and the arrangement of the book so orderly, that anyone with a conception of the first principles of mechanical design will be able to study the book profitably. Designers of machinery of all classes, as well as inventors and those engaged in the development of machines in which mechanisms and mechanical movements of the type described are used, will find this book a most valuable addition to their engineering library.

* * *

In order to foster the trade relations between the United States and the Levant, a new publication has been started known as the *Levant American Commercial Review*, 27 William St., New York City, of which the first number has just been published. This number contains several interesting articles intended to inform American business men of the possibilities of markets in the Levant. It also contains a review of what the Government does to help the American merchant.

WAR-TIME EXPERIENCE WITH WOMEN IN THE METAL TRADES[1]

REQUIREMENTS OF WAR HAVE DEMONSTRATED WOMEN'S EFFICIENCY IN MACHINE SHOP WORK—WOMEN SUPERIOR TO MEN IN SOME RESPECTS—EQUAL WAGES FOR EQUAL WORK THE GENERAL RULE

THE following summarizes the information obtained from 131 concerns employing 335,015 men and 49,823 women, and treats of the comparative wages and output of men and women, the hours of work, and numerous other matters of general interest and of practical value to employers contemplating the introduction of female labor. The problem is discussed from the standpoint of factory experience; the broad question as to whether the employment of women in the metal trades is desirable on social grounds is not taken up.

The investigation showed that no extensive substitution of women workers for men has as yet taken place in these trades and in 95 establishments reporting on this specific point only 10,657 women were employed on work formerly performed exclusively by men, and approximately half of this number were in only 10 munitions establishments. The work done by women in the metal trades embraces a great variety of processes from the operation of ordinary drill presses and lathes to coremaking, inspecting and assembling mechanical parts, and many precise machine operations. In the main, however, their work has been confined to the lighter processes in which rapidity and dexterity are more important than technical skill acquired by long training. Repetitive work is exceptionally well adapted to female labor.

Comparative Output of Men and Women

Comparing the output of men and women, it is found that in 64 establishments of the 97 furnishing specific information on this point and where men and women were employed on the same processes, the output of women was equal to, and frequently greater than, that of men. In only 15 establishments was the output of women less than that of men on all operations on which both were employed. In the remaining 18 their production, although less in some operations, equaled or exceeded that of men in others.

A highly favorable account of the efficiency of women comes from an automobile plant where they are employed in twenty-three departments on assembling and inspecting materials and on many types of machine work. In this case the comparative output of women on identical processes was almost invariably greater than that of men and in some cases quite disproportionately so. In one case a woman employed on a nut-tapping machine turned out at the end of her first week about double the output of the man working next to her. After endeavoring to equal her speed for a few days, the man quit and was replaced by another woman who is now very nearly the equal of the first. In a gear-manufacturing establishment where women do sandblasting, grinding, drilling, and broaching, their output is from 15 to 25 per cent higher than that of the men, and in a munition plant manufacturing fuses, women operatives on drill presses and milling machines were found to be from 25 to 50 per cent more rapid than men. A manufacturer of small metal parts for munitions states that women drill press operators finish 196 parts an hour on day work, while men on the night shift finish only 146 an hour. Although day and night work are not exactly comparable, the output difference is enough to indicate the superiority of the women in this case.

Employers generally commended women as being more thorough and conscientious, as producing less spoiled work, and as being more careful with tools. Even where the quantity of work produced is less than that of men, the quality is frequently better. Women were also said to be more regular in production, and did not show the tendency to restrict output which is sometimes characteristic of men.

Occupations Unsuited to Women

Whether technical training would make women the equal of men in work of higher character cannot be determined from available experience. At present their lack of training automatically excludes them from highly skilled work. It is noted, however, that there are certain operations which no employer reports as being performed as well by women as by men—for instance, lapping and brazing, both of which require considerable skill. Again, women have not proved themselves the equal of men in such comparatively heavy work as chipping castings and machine filing. Most manufacturers agree that women should not be employed on heavy work or in processes exposing them to gases, fumes, or unusually high temperatures.

Women Generally Getting Equal Wages

A comparison of women's wages with those of men engaged on the same processes in the 112 establishments making complete statements on output and wages shows that in 56 women receive equal pay, and in 28 equal piece rates but lower time rates. In only 28 establishments, or 25 per cent of the total, are women paid a lower scale than men for both piece-work and time-work. In these cases the difference ranges from 10 to 20 per cent, although in isolated instances it was 30 per cent or even more. Among reasons assigned for a lower wage scale for women were their lower efficiency while learning and the additional expense required for special equipment and more supervision, or their need for skilled assistance, such as in setting up machines, or for help in heavy lifting. At times, however, it appeared that lower wage rates had been based on only slight differences in the character of the work.

Hours of Work

Working hours of women are largely dependent on the labor laws of the respective states. Nevertheless, in 56 establishments out of 105, women were found to be working fewer hours than the legal limit. In most states represented in this investigation the legal maximum is 54 hours per week. In Ohio, however, it is 50 hours and in California, 48.

Experiments with Rest Periods

Only twenty establishments had maintained stated rest periods; these, however, employed 18,546 women workers. The periods vary in length from five to fifteen minutes, a frequent arrangement being a ten-minute rest in the middle of the morning and ten minutes more in the afternoon. Although experience with rest periods is thus limited, the results were distinctly satisfactory. In British munition factories where the rest periods are extensively employed, experience proves definitely that such rest periods are advantageous to employers as well as to employes, and demonstrates the wisdom of their more general adoption.

Training of Women Workers

Successful utilization of women depends very largely on the methods of selection and training as well as on the adaptation of plant organization and equipment. Of the three methods of training ordinarily resorted to, namely, by trade schools, by foremen, or by special factory training departments, the last is undoubtedly the most effective.

Twelve establishments covered by the investigation had installed special training departments, in which small groups of new female employes are instructed under actual factory conditions in a room separate from the rest of the plant. The training of each individual is directed toward the acquisition of high efficiency in a specific operation. After the operation has been explained and illustrated, each individual is allowed to start actual productive work under careful supervision. The use of precision tools and the reading of blueprints is usually made part of such a course, which may cover from three days to two weeks, according to the character of the work involved and the ability of the worker. In some cases several factories have combined to

[1] From a report issued by the National Industrial Conference Board, 15 Beacon St., Boston, Mass.

maintain training facilities of this type. Comparatively few establishments recruit workers from local industrial schools. The majority train the women directly in the factory, and there the active cooperation of competent foremen is of primary importance.

There are some serious disadvantages in this method as stated by one manufacturer who says: "Our experience is that the old-line foremen are prejudiced against the employment of women, and will be antagonistic in their attitude, will prejudge the possibilities adversely, and under these conditions their employment will be doomed to failure. Supervision by a broad-minded person convinced of the possibility of using women advantageously, and competent to adapt and alter the method of work, is essential." This type of supervison is conspicuous in plants where the best results have been secured.

Women's Attitude toward Work

General experience has shown that women are "more teachable," "quick to learn," and that they "follow instructions better" than men. In fact, in 103 establishments it was found that the attitude of women toward their work was considered to be as good or better than that of the men; in only 8 was it regarded as worse. Women are generally reported as taking a more personal attitude toward their work which is reflected on the one hand in greater sensitiveness to criticism and on the other in increased loyalty.

Attendance

In 84 of 115 establishments the attendance of women employes was stated as equal to or better than that of men. In 31 it was worse; these 31, however, included 18,037 women employes, or 47 per cent of the total number of women in the establishments reporting attendance. Experience in other countries, notably in Great Britain and in France during war time, indicates quite definitely a poorer standard of attendance among women than among men. Contrary to rather generally expressed opinion, it appears that the attendance of married women was fully equal to that of younger unmarried girls.

Labor Turnover

Greater stability of female labor was generally indicated by the information gathered in the course of the investigation. Of 94 employers reporting on this subject, 60 stated that the record of the women was better than that of the men; 26 that there was no difference; and only 8 that the turnover among women employes was higher. In this respect, therefore, the results are exceptionally favorable to employment of women.

Changes in Organization and Equipment

The most frequent factory change necessitated by the introduction of women workers is the employment of additional supervisors and of helpers for heavy lifting. Although the need for such supervision and assistance deters some manufacturers from employing women, many experts in scientific management contend that, even if male workers only are employed, such intensive supervision is a most effective means of increasing production.

Several large employers place their women employes in separate departments or factories. Others with equal success employ them side by side with men. Where women workers were taken on for the first time, improvements were almost invariably made in factory surroundings, such as safeguarding machinery, provision of hospital facilities, lunch rooms and rest rooms. It was, furthermore, the general consensus of opinion that the expenditure for such improved accommodations had been fully justified by the results.

In conclusion it may be said that the experience assembled in the course of this study shows clearly that the employment of women in machine shop work in the metal trades is practicable. The increasing scarcity of men and the certainty that more will be withdrawn from industry for military service make the more extensive employment of women almost inevitable, at least for the duration of the war.

Thus far manufacturers have found no lack of women applicants for positions. Most of their workers are drawn from other industries, or from department stores, offices, restaurants, laundries, and domestic service. In many cases the wives and dependents of men in military service, and friends and relatives of former employes, have been given preference. The employment of women not previously wage-earners is as yet the exception, but employers are now beginning to draw upon this class. The permanence of women's position in the metal trades will probably depend in part on the attitude and economic strength of male workers after the war. Surprisingly little opposition to the introduction of women has thus far been encountered from men, possibly because of the relatively small number of women thus far employed or because the urgency of the step was recognized. Yet one employer expresses the view that "When jobs are not so easy to get it will be different." Others, however, were of the opinion that women would continue as a permanent factor in the metal trades, especially on the lighter kinds of work. Whatever the ultimate experience may be, the ability of women to perform a variety of operations in the metal trades has been convincingly demonstrated.

* * *

METHOD OF EXPRESSING TOLERANCES

BY J. C. P. BODE[1]

There are a number of ways of expressing tolerances, each with a point in its favor, and any one of the systems may be universally adopted with success, thus eliminating the confusion resulting from the use of too many systems. The three methods given demonstrate the difficulties.

There is first the old way; for example, 0.236 ± 0.002. Any mechanic will understand this expression without further explanation; still, in places where precision work is being done tolerances are expressed thus: 0.236 ± 2, which means exactly the same. The rule is that the figure expressing the tolerance will be placed under the main dimensional figure, so that the last figure of the main dimension is in line with the last tolerance figure; thus: $\begin{matrix}0.236\\ \pm 2\end{matrix}$, which indicates a maximum dimension of 0.238 inch and a minimum of 0.234 inch. According to the same rule, 0.2362 ± 0.0002 would be written as follows: $\begin{matrix}0.2362\\ \pm 2\end{matrix}$, meaning 0.2364 for the high and 0.2360 for the low limit. The advantage claimed for this system over the older method is that one can find the high and low limit by a simple addition or subtraction, which can be taken in quickly by the eye; furthermore, tolerances written in this manner take up less room on a drawing, which is often desirable when many dimensions are required in a small space. This method will be found very convenient when one has once become used to it. Its only drawback is that it is not well enough known. In one case the writer knows of, it caused considerable delay, because an outside firm asked for an explanation, not being familiar with it, and new men often have to be instructed in its use.

In some shops, it is understood that all tolerance figures are always thousandths unless otherwise specified. Thus, 0.2362 ± 2 means plus or minus 0.002. In order to express hundredths, the drawings will read 0.2362 ± 20; and ten-thousandths in this shop will be written $0.2362 \pm 2/10$.

There is enough merit in any of these methods to warrant its adoption universally. The only trouble with the latter two, however, is that they are confusing to those not familiar with them. Especially to one accustomed to the second method, the third one would probably be very awkward and might cause serious mistakes. Neither does the third method permit the finding of the high and low limits as easily as the second.

The question therefore is: Is it advisable to adopt a new way of expressing tolerance in one's own shop, or is it advisable to stick to the method that is most generally used? A few opinions on this subject by practical men will no doubt bring out many interesting points and may lead to the universal use of the best method.

[1]Address: 65 Ashley St., Hartford, Conn.

B·S TRADE MARK

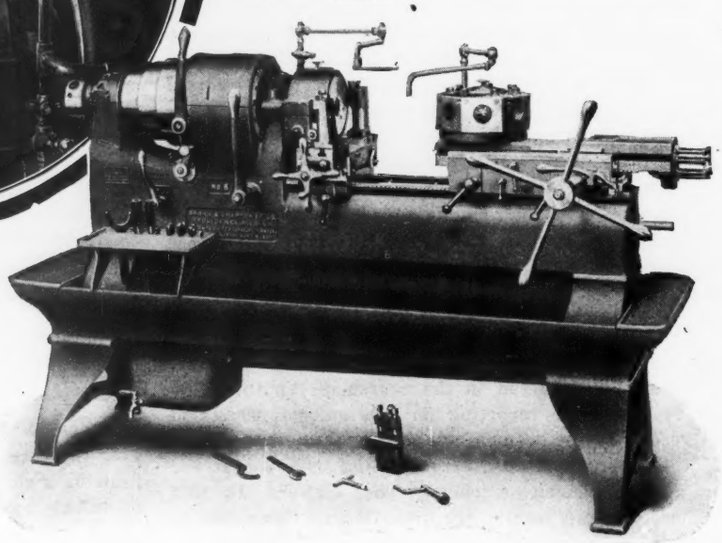
ACCURACY—The First Requirement,

"BROWN & SHARPE

For Steady, Fast,

The Twist of a Wrench Adjusts the Chuck of *This* Screw Machine to *Any* Size

Not only does this feature of B & S Nos. 4 and 6 Wire Feed Screw Machines make a material saving on the first cost, but saves time as well as dollars throughout their years of efficient service because no time is lost in adjusting special chucks or in searching for collets.



A simple adjustment, as shown in cut above, similar to the method used in adjusting the jaws of a universal chuck, is all that is necessary to handle round, square or hex stock of any size within capacity of machine. It also automatically compensates for any slight variation in the size of bar.

This automatic-chuck feature together with

Three-Lever Centralized Control

practically eliminates all lost motions.

After tools are set chuck is opened and stock advanced by the slight throw of a handy lever. The return of this lever to its original position closes and locks the chuck.

A second lever, also on the headstock, is employed for starting, stopping and changing speeds while the simple movement of a third lever, close by, changes feed of turret slide in conjunction with a lever just behind the pilot wheel of turret slide which is manipulated with the right hand in connection with the handling of a pilot wheel to bring tools up to cut.

Other reasons why your bar work should be handled on these machines—reasons that spell economy and increased production—are explained in detail in our Catalog 21-G. Your request will bring a copy.

BROWN & SHARPE *Heavy Wire Feed* Screw Machines

Offices:

NEW YORK, N. Y., 20 Vesey St. PHILADELPHIA, PA., 1103-1105 Liberty Bldg. CHICAGO, ILL., 626-630 Washington Blvd. ROCHESTER, N. Y., 415 Chamber of Commerce Bldg. SYRACUSE, N. Y., Room 419 University Block. PITTSBURGH, PA., 2538 Henry W. Oliver Bldg.

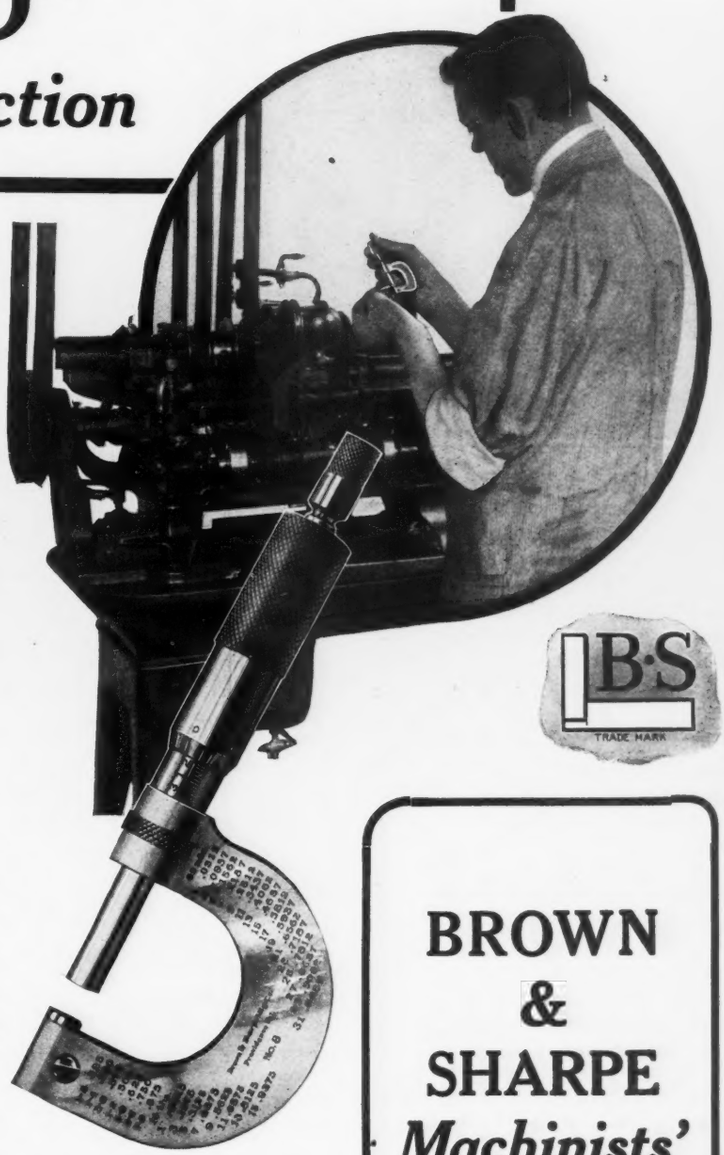
Canadian Representative:

MONTREAL, TORONTO, WINNIPEG, CALGARY, VANCOUVER, ST. JOHN, SASKATOON, The Canadian Fairbanks-Morse Co., Ltd.

Brown & Sharpe Mfg. Co.,

HANDINESS—An Attribute of Every B & S Product

EQUIPPED"
Quality Production



An Increase in Production and Quality With a Corresponding Decrease in the Scrap Heap

naturally follows the use of Brown & Sharpe Tools. The confidence that encourages competence is inspired by the use of these handy, accurate tools and is soon reflected in the high degree of efficiency their use promotes.

Numbering over a thousand different varieties, they

Cover Thoroughly Every Precision-Tool Requirement

and represent a development covering over half a century.

Practically every variety of measuring tool is used in our own shops in the manufacture of our extensive line of machinery, and our small-tool designers have worked with the advantage of first-hand information as to the needs of the man in the shop.

Every care is taken that the highest quality of workmanship be maintained, resulting in a line of machinists' tools that is world-known for its uniform quality. Not only the kits of your tool-makers and machinists but

Your Tool Cribs Should be "Brown & Sharpe Equipped"

If interested in steady, fast, quality production you should have a copy of our Catalog 27. Send for your copy today.

Providence, R. I., U. S. A.

B·S TRADE MARK

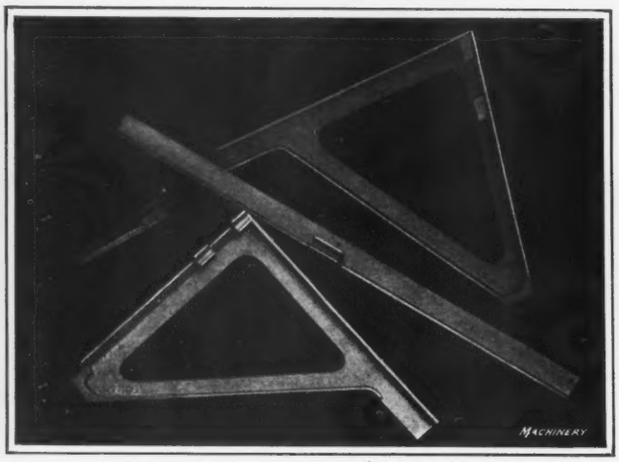
BROWN & SHARPE *Machinists'* Tools

Representatives:

BALTIMORE, MD., Carey Machinery & Supply Co. CINCINNATI, O., INDIANAPOLIS, IND., The E. A. Kinsey Co. SAN FRANCISCO, CAL., Pacific Tool & Supply Co. CLEVELAND, O., DETROIT, MICH., Strong, Carlisle & Hammond Co. ST. LOUIS, MO., Colcord-Wright Machinery & Supply Co., SEATTLE, WASH., Perine Machinery Co. PORTLAND, ORE., Portland Machinery Co.

MOUNT VERNON CASTINGS

The process of die-casting is generally recognized as of great advantage in the manufacture of parts in large quantities. There is, however, a demand for very fine castings, approaching the accuracy and finish of die-castings, in cases where the quantity to be manufactured is limited. To meet this demand, the Mount Vernon Co., Mount Vernon, N. Y., has developed a process by means of which castings are made in aluminum, bronze, and brass without dies, thus reducing the cost, which



Castings made to Accurate Finish without Dies

is essential in manufacturing a limited number. The result is a casting of a high degree of finish. The surface is very smooth, and the castings are held to the required dimensions within close limits of accuracy. Castings may be made in almost any shape, with walls as thin as 1/16 inch, or perhaps thinner. The castings made by this process are especially desirable for experimental mechanisms, etc.

* * *

PRINCIPLES OF THE ALIEN ENEMY ACT

As there is considerable misunderstanding among business men as to the exact interpretation of the Alien Enemy Act, the alien property custodian, A. Mitchell Palmer, has issued a clear and concise statement, which will be of value to all business houses engaging either in domestic or foreign trade.

According to this statement, there are two ways of making war against the enemy—one by force of arms, the other by force of economic pressure. But in order to properly understand the acts that have been passed by Congress to take care of the second of these methods, that of making war by force of economic pressure, it is important to know exactly who is an "enemy" under the act, and what is "enemy" property.

Briefly defined, enemy property includes every kind of property, money, securities, land, indebtedness, accounts receivable, etc., belonging to an enemy. Even if the property is held in the name of another—by a dummy or in trust—if the real beneficiary is an enemy, it is enemy property. An enemy under the Alien Enemy Act is defined as any person coming under the following definitions:

1. Any person, regardless of citizenship or place of birth, who is within the boundaries of Germany, Austria-Hungary, or their allies, or within the territory actually occupied by their military or naval forces. A peaceful and law-abiding German or Austrian citizen residing in the United States is not an enemy; but an American citizen living in enemy territory is an enemy.

2. A person residing outside of the United States and doing business within the territory of enemy countries or their allies.

3. A corporation, if incorporated within the territory of enemies or their allies, or incorporated in any neutral country and doing business within the territory of enemies or their allies.

4. An official or agent of an enemy government or any subdivision thereof.

5. All natives, citizens, or subjects of Germany or Austria-Hungary interned by the War Department.

6. All citizens or subjects of Germany or Austria-Hungary resident outside of the United States who are (a) wives of officers, officials, or agents of Germany or Austria-Hungary, wherever resident; (b) wives of persons within the territory (including that occupied by military and naval forces) of Germany or Austria-Hungary; or (c) wives of persons resident outside the United States and doing business within enemy territory.

7. Citizens or subjects of Germany or Austria-Hungary who are prisoners of war or who have been or shall be interned by any nation associated with the United States in the war.

8. Citizens or subjects of Germany or Austria-Hungary who since April 6, 1917, have disseminated or shall hereafter disseminate propaganda to aid any enemy nation or to injure the cause of the United States, or who have assisted, or who shall assist in plotting against the United States or any nation associated with the United States in the war.

9. Citizens or subjects of Germany or Austria-Hungary who are included or who shall be included in the "Enemy Trading List" published by the War Trade Board.

10. Citizens or subjects of Germany or Austria-Hungary who at any time, since August 4, 1914, have been resident within enemy territory.

Numbers 2, 6, 8, 9, and 10 apply only to persons resident outside of the United States.

Every citizen of the United States is requested to help the Government by mailing to the Bureau of Investigation, Alien Property Custodian, Washington, D. C., reports or information on enemy-owned property.

* * *

HELPING UNCLE SAM

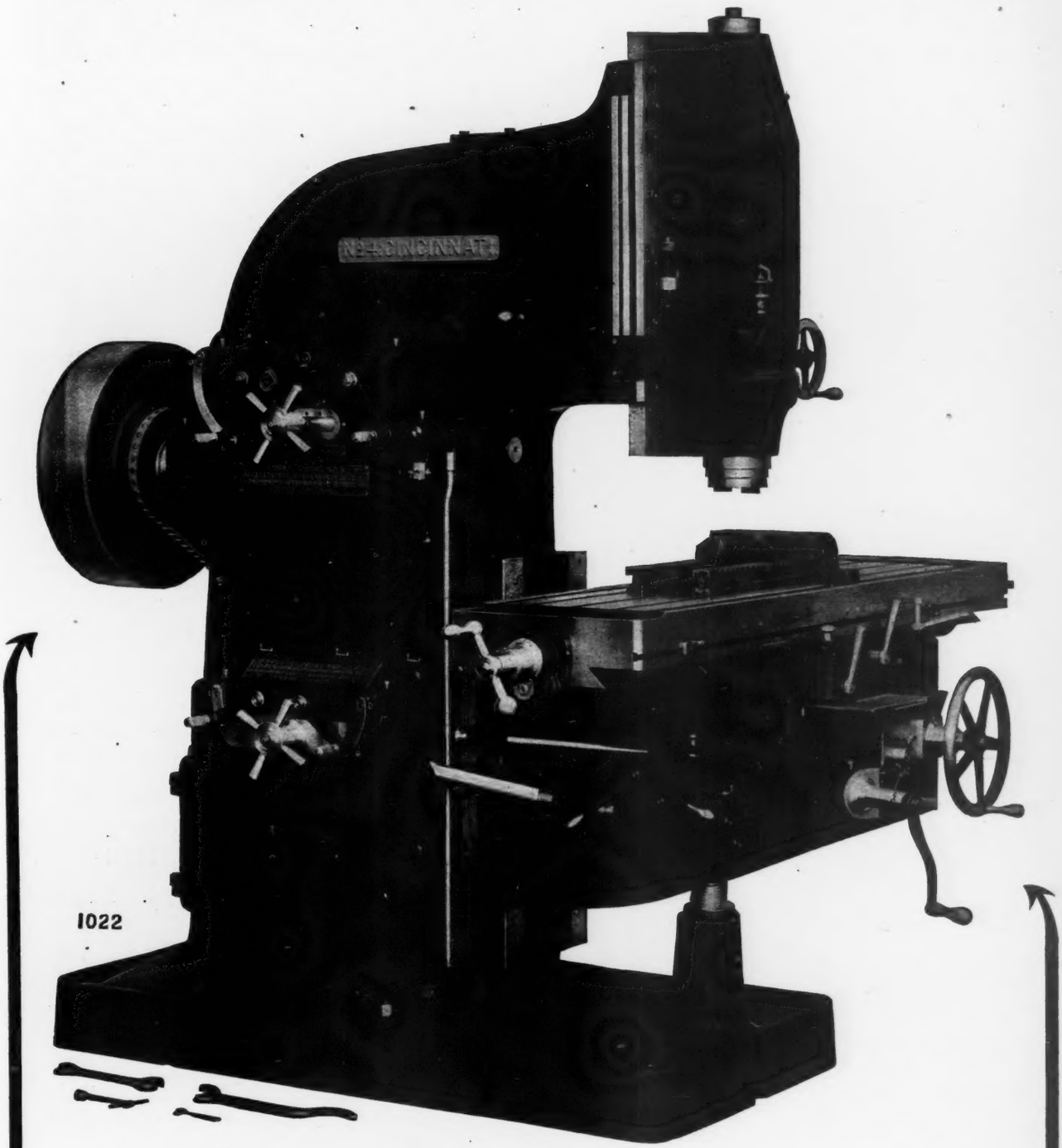
Courses of instruction were announced on page 1166 of the August number of MACHINERY, covering the use of munition limit gages and their measurement, to be given at the Bureau of Standards. The Bureau of Standards now announces that the first course will begin on September 3, this being the longer, or Course A, which will cover about a month. No tuition fee is charged for any of the courses.

The Bureau of Oil and Natural Gas Conservation, United States Fuel Administration, Washington, D. C., is desirous of securing the services of six field inspectors whose work will consist of visiting the larger oil and gas producing localities, and ascertaining the conditions as to wastage of oil and gas. The bureau also desires the services of eight fuel oil combustion engineers. As far as possible, all are desired to volunteer their services to the Government during the period of the war, but if this is not possible, a fair remuneration, together with the necessary expenses, will be paid. Only men having had experience in these lines need make application.

The United States Civil Service Commission announces open competitive examinations for inspectors of safety appliances, for men only, on October 2 and 3, 1918, the examinations to be held at various places in the United States, as will be specified upon application to the Civil Service Commission, Washington, D. C. The positions carry a salary of $3000 a year, with necessary allowances for expenses incurred while absent from headquarters in discharge of official duties. The duties of safety appliance inspector comprise the making of inspections and reports as required by the Safety Appliance Acts, and inspectors may also be required to investigate accidents. They must be between twenty-five and fifty years old on the date of the examination. Applicants should at once apply to the Civil Service Commission, Washington, D. C., for Form 1933, stating the title of the examination desired.

The Service Bureau of the Committee on Public Information, which gives information as to officials, functions and location of all government departments in Washington, is located at 15th and G Sts., Washington, D. C. Owing to the fact that there often is great difficulty in finding the proper official or bureau, this Service Bureau has been instituted as an aid to manufacturers and others who come to Washington on business. By appealing to the Service Bureau upon arrival in Washington, a great deal of time may be saved in locating the proper official or department.

Cincinnati Verticals



Unusual Spindle Power.
Heat Treated Alloy Steel Hardened Gearing.
Massive Spindle Head Construction.
Handy—Can mill around a rectangle without stopping feed or speed.

These are some reasons why you should use Cincinnati Verticals

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

PERSONALS

C. C. HORNER has been appointed manager of the Cleveland office (Leader-News Bldg.) of the William F. Davis Machine Tool Co., Inc.

WILLIAM DICKS, recently with the Buffalo branch of the Wire Wheel Corporation of America, has been appointed general superintendent of John W. Jepson, Inc., Buffalo, N. Y., manufacturer of automobile and hardware specialties.

FREDERICK R. BANKS has resigned his position as assistant equipment engineer of the Remington Arms Union Metallic Cartridge Co., Inc., Bridgeport, Conn., and is now chief engineer with the McNab & Harlin Mfg. Co., Paterson, N. J.

F. H. CHARBONO, who has represented the Independent Pneumatic Tool Co., Chicago, Ill., in the east for many years, traveling from the New York office, has been appointed manager of the southern district, with headquarters at 1721 Jefferson Co. Bank Bldg., Birmingham, Ala. Mr. Charbono succeeds George C. Wilson.

GEORGE C. MCKAY, for the past five years sales engineer in southern Ohio and western Pennsylvania for the S K F Ball Bearing Co., of Hartford, Conn., has started in business for himself as a sales engineer at 4247 Greenlee Ave., Cincinnati, Ohio. He will handle the entire output for a number of years of the line of electrical drills manufactured by the Automatic Electrical Tool Co., of Cincinnati, Ohio.

GEORGE M. NAYLOR has left his position as assistant sales manager of the T. B. Woods Son's Co. of Chambersburg, Pa., and is now connected with the Fairbanks Co., New York City, as manager of this company's power transmission division. Mr. Naylor is an experienced transmission engineer and will have under his direction the power transmission division of all the branch houses. He will be located at the main office, 416 Broome St., New York City.

WILLIAM F. SCHWEIGERT, who has been associated for nearly thirty years with the Niagara Machine & Tool Works, Buffalo, N. Y., manufacturers of machines and tools for sheet-metal work, has been elected secretary of the company. Mr. Schweigert has been connected mostly with the sales department, and has attended to the most important work on the road. In his new office, he will still continue his connection with this department, and will keep in close personal touch with the trade.

ALBERT BROWN, of London, has been elected president of the Society of Motor Manufacturers and Traders of Great Britain. Mr. Brown is one of the founders of the firm of Brown Bros., 22 Great Eastern St., London, E. C., and is also connected with the New Departure Mfg. Co., of Bristol, Conn. His aim will be to secure the cooperation of American, British, and French business men in working out the many complex problems involved in after-the-war development. Mr. Brown is desirous of obtaining suggestions from members of the motor trade societies in America.

E. P. DILLON, manager of Power Division, New York office of the Westinghouse Electric & Mfg. Co., has resigned to become general manager of the Research Corporation of New York. Mr. Dillon came to the Westinghouse Electric & Mfg. Co. in 1909, having been previously connected with various mining and electrical companies in Colorado. For several years, he was assistant to the manager of the Railway & Lighting Department at East Pittsburg, being in charge of the power house and apparatus work. In 1917, he was transferred to the New York office as manager of the Railway and Power Divisions.

OBITUARIES

CAPTAIN EDWARD H. PHILLIPS, Company E, 104th Infantry, an employe of the L. S. Starrett Co., Athol, Mass., was killed in action in France, July 25. Capt. Phillips was an example of the finest type of young American manhood, and last spring received the *croix de guerre* from the French Government. He was one of the 124 employes of the L. S. Starrett Co. in the military or naval service of the United States and Great Britain, and was a sergeant when Company E of the 104th Infantry was first formed, but was rapidly promoted until he became a captain.

CHAUNCEY PORTER GOSS, president of the Scovill Mfg. Co., Waterbury, Conn., died July 19, at an age of eighty years. Mr. Goss was born in Pittsford, N. Y., August 5, 1838. He came to Waterbury in 1862 and entered the employ of the Scovill Mfg. Co., as an assistant bookkeeper. His rise in the company's service was rapid. In 1864 he was made secretary of the company, and in 1866 he was chosen treasurer, and he later became general manager. In 1900 he was chosen president of the company and occupied that post until his death. He was an executive officer of rare ability, which was displayed both in manufacturing processes and in his methods of handling men.

COMING EVENTS

September 10—Twenty-sixth annual convention of the Traveling Engineers' Association, in Chicago, Ill. Secretary, W. O. Thompson, General Offices, New York Central Railroad, Cleveland, Ohio.

October 7-12—Joint convention of the American Foundrymen's Association and the American Institute of Metals in Milwaukee, Wis. Concurrent with these meetings there will be an exhibition of foundry equipment, machine tools, and accessories.

SOCIETIES, SCHOOLS AND COLLEGES

University of Vermont, Burlington, Vt. Catalogue for 1917-1918 with announcements for 1918-1919.

Michigan College of Mines, Houghton, Mich. Year Book for 1917-1918 with announcement of courses for 1918-1919.

University of Missouri, School of Mines and Metallurgy, Rolla, Mo. Catalogue for 1917-1918, containing calendar for 1918-1919, outline of courses, and other information relating to the university.

NEW BOOKS AND PAMPHLETS

Copper. 104 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 73 of the Bureau of Standards. Price, 20 cents.

German Trade and the War. By Chauncey Depew Snow and J. J. Kral. 236 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C. Price, 25 cents.

Wartime Employment of Women in the Metal Trades. Research Report Number 8. 79 pages, 6 by 9 inches. Published by the National Industrial Conference Board, 15 Beacon St., Boston, Mass.

The Effect of Addition Agents in Flotation. By Martin Harmon Thornberry and Horace Tharp Mann. 48 pages, 6 by 9 inches. Published by the School of Mines and Metallurgy, University of Missouri, Rolla, Mo., as No. 2 of Technical Series, Vol. 4.

Analyses of Mine and Car Samples of Coal Collected in the Fiscal Years 1913 to 1916. By Arno C. Fieldner, Howard I. Smith, J. W. Paul, and Samuel Sanford. 478 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 123.

Thermal Expansion of Alpha and of Beta Brass between 0 and 600 degrees C. By P. D. Merica, associate physicist, and L. W. Schad, assistant physicist of the Bureau of Standards. 20 pages, 7 by 10 inches; illustrated. Published by the Department of Commerce, Washington, D. C., as Bulletin No. 321 of the Bureau of Standards. Price, 10 cents.

Tests of Large Bridge Columns. By J. H. Griffith and J. G. Bragg. 139 pages, 7 by 10 inches. Published by the Department of Commerce, Bureau of Standards, Washington, D. C. Price, 30 cents.

The investigation gives a comparative analysis of the experimental data obtained when testing eighteen large bridge columns in a 10,000,000-pound testing machine. The action of each column as a whole was studied in a range of loadings taken to destruction of the members. Numerous observations were made to determine the behavior of lattice bars, pin plates, diaphragms, etc. The causes and effects of initial strain from riveting and fabrication is discussed.

Bulletin No. 2 of the Bureau of Standards. 162 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C. Price, 25 cents.

This bulletin contains the following articles: "Relative Sensibility of the Average Eye to Light of Different Colors and Some Practical Applications to Radiation Problems"; "Calculation of the Constants of Planck's Radiation Equation: An Extension of the Theory of Least Squares"; "Luminous Radiation from a Black Body and the Mechanical Equivalent of Light"; "An Experimental Study of the Fahy Permeameter"; "Note on Electrical Conduction in Metals at Low Temperatures"; "Reflecting Power of Tungsten and Stellite"; and "A Method for Testing Current Transformers."

An Investigation of Twist Drills. By Bruce W. Benedict and W. Penn Lukens. 144 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 103. Price, 60 cents.

This bulletin is the first of a series giving the results of extensive experiments which have been performed for the purpose of determining what factors combine to produce the most efficient drill. The drills tested included the standard types of many prominent drill manufacturers as well as drills especially designed for experimental purposes. Illustrations of the machines used in making the different tests, and of the results in chip formation, together with many comparative tables, serve to show the effects produced by varying the helix angle, method of grinding, cutting angles, speeds and feeds, and lubrication.

Modern Management Applied to Construction. By Daniel J. Hauer. 194 pages, 6 by 9 inches. Published by McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $2.50.

The author's experience as an economist and consulting engineer enables him to accurately set forth the principles of scientific management as applied to construction. The principles which have proved so successful in building up an organization in the manufacturing field are now considered essential in the building up of a successful contracting organization, and the methods of applying those principles are given under the following heads: What is Scientific Management, Old Versus New Management, Principles of Modern Management, Finances and Efficiency, Fundamentals in Choosing Type and Amount of Plant, The Application of Motion and Time Studies, Application of Modern Management, Cost Keeping and Bookkeeping, Systematizing Construction, The Effect of Modern Management on Workmen. This book should be of value to contractors who are just starting in business, and to the older concerns that desire to obtain the highest possible degree of efficiency in their organization.

The Starrett Book for Machinists' Apprentices. By Howard P. Fairfield and Carl S. Dow. 184 pages, 5 by 8 inches. Published by L. S. Starrett Co., Athol, Mass. Price, 50 cents.

This is a book for machinists' apprentices which describes in a clear and concise manner the methods employed in laying out work from blueprints and the correct methods to use in machining and gaging the different classes of work encountered in an ordinary machine shop. Useful tables and formulas for solving the many problems with which the experienced machinist is confronted are also given in a convenient form. This information is supplemented by illustrations and is included under the following heads: Reading Working Drawings, Measuring Tools, Flat Work, Round Work, Vernier Calipers, Height Gage, Micrometer Calipers, How to Read Micrometers, How to Read Vernier, Transferring Measurements, Steel Rules, Spring Dividers and Calipers, Fits and Fitting, Limits for Tolerance, Bench Work, Protractors, Chipping, Filing, Polishing, Use of Hacksaws, Drilling, Tables of Feeds and Speeds and The Lathe. The latter chapter includes instructions on the care of lathes and lathe tools and all necessary information regarding taper turning, thread cutting, and similar operations. The book also has information on toolmaking, jigs and fixtures, grinding, locating and aligning machinery, elementary algebra, shop and machinery formulas, mensuration, and mechanics.

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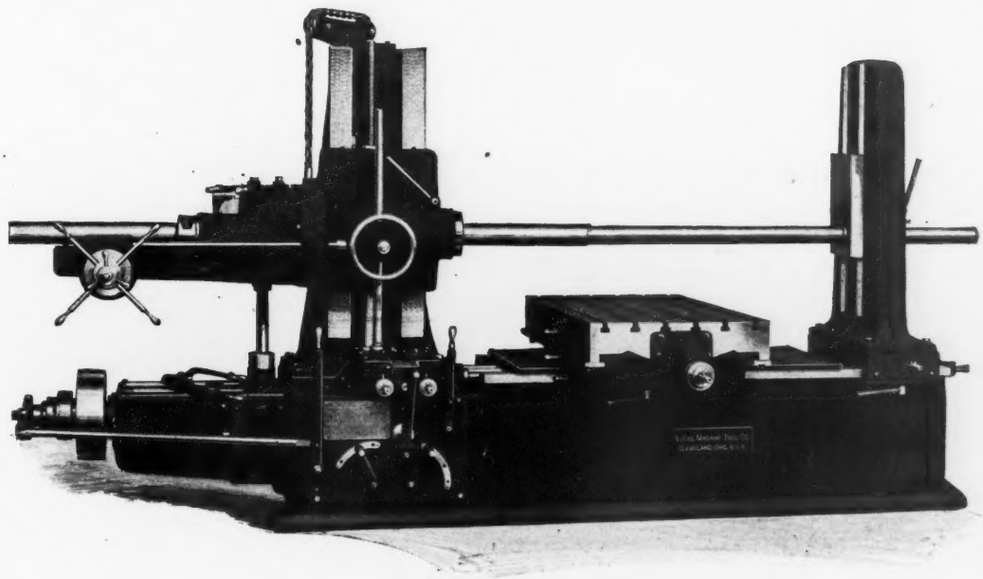

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WILL BE THE STANDARD

IN THE FUTURE

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF CLEVELAND, OHIO, U.S.A.

Machine and Fitting Shop Practice. Vol. I. By George W. Burley. 212 pages, 5 by 7½ inches; 194 illustrations. Published by the D. Van Nostrand Co., 25 Park Place, New York City. Price, $2.

The present book is the first volume of a series of books on machine shop practice and deals with measurements and gaging, laying-out work, bench-work, chipping, filing, and scraping. The author is head of the machine tool department and lecturer in engineering at the University of Sheffield, England, and the book has been written especially for shop apprentices and students in engineering and trade schools. Hence, it deals chiefly with elementary principles, but an attempt has been made to make it as up-to-date as possible, so as to make it useful as a book of reference for those interested in modern shop practice. Attention has been given to processes and operations and tools and instruments, rather than to actual machines. The present volume, as mentioned, deals with operations that do not in general, involve the use of machine tools. The following volume deals more directly with actual machine tool work. The present book contains chapters on materials of construction, shop measurements, and measuring instruments; gaging and gages; setting out tools and operations; the vise; the hammer and chisel; chipping; files, their forms and uses; scrapers and scraping; fractional and decimal equivalents; metric and English equivalents; and height differences for standard sine bar.

NEW CATALOGUES AND CIRCULARS

International Motor Co., 252 W. 64th St., New York City. Circular of "Mack" motor trucks.

General Electric Co., Schenectady, N. Y. Circular descriptive of circular coil transformers of the oil-insulated, self- or water-cooled type.

American Gage Co., Dayton, Ohio. Circular descriptive of the American amplifying gage, illustrating applications of this gage on flat and cylindrical work.

Armstrong Cork Co., Pittsburg, Pa. Circular treating of "Nonpareil" insulating brick for heat-treating furnaces and ovens. Copies will be sent free upon request.

Ross Heater & Mfg. Co., Inc., 504 Mutual Life Bldg., Buffalo, N. Y. Circular advertising Ross crosshead-guided expansion joints, surface condensers and multi-head water heaters.

Vonnegut Machine Co., Indianapolis, Ind. Circular illustrating and describing the Eaglesfield motor-driven molder, which is made in two sizes, 6 by 4 inches and 12 by 4 inches.

Lambert Machine & Engineering Co. Cleveland, Ohio. Circular illustrating and giving specifications for the Lambert horizontal boring machine for boring, milling, drilling, and tapping.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 48938, showing applications of electric grab-bucket hoists and giving specifications for the various sizes.

Electro-Stylograph Co., 1 Madison Ave., New York City. Circular illustrating and describing the electro-stylograph, an apparatus for marking tools, gages, dies, etc., by the application of the electric current.

Nice Ball Bearing Co., 30th and Nicetown Lane, Nicetown, Philadelphia, Pa. Catalogue 44 and price lists of Nice double annular ball bearings, combination ball bearings, thrust ball bearings, and diamond ball retainers.

St. Louis Machine Tool Co., 932 Loughborough Ave., St. Louis, Mo. Circular illustrating and giving specifications for the complete line of St. Louis grinders. Circular of St. Louis polishing machines and countershaft brackets.

L. S. Starrett Co., Athol, Mass. Circular of Starrett speed indicators equipped with new rubber tips for pointed and hollow centers, which remove the jar and produce a stronger frictional contact between the shaft and the instrument.

Cincinnati Planer Co., Cincinnati, Ohio, has begun to issue a monthly shop bulletin for its employes known as "Plane-ings." The paper contains news notes and personals relating to employes, announcements relating to the shop, notes of a patriotic character, letters from former employes now at the front, etc.

Landis Machine Co., Inc., Waynesboro, Pa. Catalogue 24 of bolt threading machines; bolt pointing machines; nut tapping machines; pipe and nipple threading machines; pipe threading and cutting machines; and chaser grinders. The catalogue describes the Landis die in detail and gives specifications for Landis rotary bolt threading die-heads.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Folder containing information on electric soldering irons and hand tools. Two views are shown of the soldering iron, which has a threaded heating core over which the tip is secured. A new automatic rack, a six-inch current-regulating plate for providing temperature control, and the "Feed-through" switch for installation on the heater cord are also illustrated.

Steel City Electric Co., 1207-1219 Columbus Ave., Pittsburg, Pa. Catalogue 33, illustrating the products made by the Steel City Electric Co. including star bushings, brass bushings, car conduit bushings, lock-nuts, fixture stems, bushing adapters, fixture hangers, conduit benders, switch boxes, outlet boxes and covers, attachment plugs, insulator supports, and various other electrical appliances and fittings.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Booklet A, pointing out the application and desirable operating features of Cutler-Hammer motor-operated brakes for alternating-current service. Dimensions, engineering data, and formula for determining the retarding torque required for any brake installation are given. The booklet lists the standard sizes of brakes which vary from 8 to 30 inches in diameter, and from 12 to 300 horsepower capacity.

Woods Industrial Engineering Co., First Bridgeport National Bank Bldg., Bridgeport, Conn. Booklet entitled "Industrial Engineering as Taught by the Woods Industrial Engineering Co.," describing a correspondence course in industrial engineering offered by the company. The pamphlet outlines the present need for industrial engineers, describes the lessons of the course that will be given, and gives details of tuition fees and other matters of interest to prospective students.

Baker R & L Co., Cleveland, Ohio. Booklets relating to the Baker R & L system of inter-departmental haulage by the use of electric industrial tractors and trucks. One of these booklets is entitled, "In What Space Will It Turn" and deals with tractors that will turn within their own length. Another booklet deals specifically with tractors, another with trucks, while a fourth folder deals with the plant behind the product, giving a brief description of the Baker R & L Co.'s plant in Cleveland, Ohio.

Conway & Co., Cincinnati, Ohio. Catalogue 3-D, illustrating and describing Conway patent friction clutches. The catalogue shows clearly the construction of the clutches both by halftone illustrations and line engravings, contains tabulated data relating to dimensions, price lists, and various miscellaneous information. Among the clutches illustrated are solid compression clutches, clamp compression clutches, split clutches, expansion clutch pulleys, compression sleeve clutches, expansion clutches, high-speed clutches, special clamp clutches, and one-revolution clutches.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 3-B, dated June, 1918, and superseding catalogue 3-B, dated July, 1916, covering switchboards, portable and precision instruments, ammeter shunts, instrument transformers, and relays. The catalogue, which covers some forty large pages of illustrations and description relating to electrical instruments, contains considerable information relating to newly developed instruments that will be of value to those who have to equip plants with devices of this kind. The catalogue differs from previous editions relating to instruments and relays in that, wherever possible, each particular type of apparatus is listed on only one page, and where more than one page is required, the several pages necessary are confined to a description and listing of one type, so that it is easy to find the information required on any particular instrument or relay in the catalogue.

Union Twist Drill Co., Athol, Mass. Catalogue H, entitled "Book of Information on Twist Drills, Reamers, Gear and Milling Cutters, and Machine Tools." The catalogue illustrates and describes the entire line of the Union Twist Drill Co.'s drills and cutters. It comprises 368 pages, 5 by 7¼ inches, and is handily thumb-indexed into the following sections: Cutters, high-power milling cutters, machine tools and fixtures, drills, reamers, arbors, and general information. The machine tools described were made originally for convenient and rapid handling of work with a high degree of accuracy in the Union Twist Drill Co.'s factory, and comprise cold-saw cutting-off machines, hob grinders, circular grinding machines, form cutter grinders, universal cutter and reamer grinders, and gaging and testing fixtures of various kinds. In addition to the regular catalogue information, the book contains a valuable selection of tables of general interest and application.

TRADE NOTES

J. M. Gilmour, 151 Lafayette St., New York City, has recently opened a shop having modern equipment for contract work.

LaSalle Tool Co., LaSalle, Ill., announces that the name of LaSalle Machine & Tool Co. has been changed to the name given above. There will be no changes in the business policies of the company.

New Process Specialty Co. has removed from the Enterprise Bldg., Milwaukee, Wis., to its new factory at 230-232 Hanover St., where it will have increased facilities for the manufacture of high-grade jigs, dies, gages, tools, and special machinery.

Mayer Bros. Co., 131 W. Rock St., Mankato, Minn., manufacturer of "Little Giant" hammers, tractors, and other "Little Giant" products, announces that the company's name has been changed to Little Giant Co., the change in name taking place September 1.

Turner Machine Co., Danbury, Conn., manufacturer of the Turner turret machines, has bought the plant and business of A. D. Quint, of Hartford, Conn., manufacturer of turret drilling and tapping machines. The equipment of the Quint plant is being moved to Danbury, Conn.

Bock Machine Co., Cincinnati, Ohio, has been purchased from Joseph Bock by W. H. Morris and J. T. Rowell, both of whom were formerly with the Greaves-Klusman Tool Co., of Cincinnati. The concern, under the new management, expects to build a line of machine tools, and do contract work on special machinery.

Giern & Anholtt Tool Works, Detroit, Mich., announce that the partnership formerly known as Giern & Anholtt has been duly incorporated under the laws of the state of Michigan under the name given above. James B. Giern is president and treasurer of the new company; A. P. Anholtt, vice-president; and R. W. McMullen, secretary.

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., manufacturers of Besly disk grinders, announce that the spindle construction and ring-oiling system for bearing lubrication, described on page 984 of the July number of MACHINERY and illustrated in Fig. 14 on page 983 of the same number, has been patented, the patent number being 1,272,493.

Standard Electric Tool Co., Cincinnati, Ohio, manufacturer of portable electric drills and grinders, has purchased the property at the corner of Western Ave. and York St., Cincinnati, Ohio, and will rebuild the property for its own use. The company expects to occupy the new buildings early in October and will then increase its equipment to about four times the present capacity.

New Standard Hardware Works, Inc., Mount Joy, Pa., is now installing a New Standard tinning plant, including the process for the hot-tinning of steel stampings, at the Buhl Stamping Co., Detroit, Mich. The installation will be in operation within the next four months. Another hot-tinning installation for tinning steel stampings has been sold to the National Enameling & Stamping Co., of Milwaukee, Wis.

Independent Pneumatic Tool Co. has leased the entire sixth floor in the Otis Bldg., at 600 W. Jackson Blvd., Chicago, Ill., which comprises 12,000 square feet of floor space. The general offices of the company will be located in the new quarters. John D. Hurley, president, states that the demand for pneumatic tools for government work and shipbuilding has made it necessary for the company to seek larger quarters.

Bowling Green Die & Tool Co., Bowling Green, Ohio, was formed and incorporated July 26, 1918, for the purpose of manufacturing high-grade dies, tools, jigs, fixtures, and special machinery. The incorporators are Clyde V. Urschel, P. M. Davidson, Fred W. Uhlman, L. D. Mercer, Harry Barron, H. J. Rudolph and R. L. Swartz. At a meeting of the stockholders, Clyde V. Urshel was elected president; W. M. Gray, vice-president; Philo S. Hankey, secretary and treasurer; and R. L. Swartz, general manager.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., announces that a contract has been let and work started on the erection of an up-to-date addition to its Cleveland plant, which is planned to double the present output. It is expected that work will be completed on the building about November 1. The necessary equipment has been ordered, and, it is believed, will be delivered and ready for installation by the time the building is completed, so that the additional production contemplated will be available very soon thereafter.

Onondaga Steel Co. Inc., Syracuse,, N. Y., specialist in the manufacture of high-speed steel converted from odds and ends of scrap high-speed steel, has plans under way for erecting four additional buildings on its property in the extremity of Eastwood, a suburb of Syracuse. The structures will be of brick, steel, and tile, and will include office, warehouse, annealing and melting buildings. The company has just completed a building for its rolling mill and hammers of 140 by 100 feet, as well as a boiler house.

Bound Brook Oil-less Bearing Co., Bound Brook, N. J., manufacturer of bushings, bearings, and washers, has made an arrangement whereby every employe who has been in the service of the company for three months is insured to the amount of $500, increasing with the length of service, and payable at his death to whomsoever he may direct the policy to be issued. The entire expense of the policy is paid by the company and applies to employes of the company's three plants, one of which is located at Bound Brook, N. J., and two at Lincoln, N. J.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich., manufacturer of electric furnaces, has let contracts to Hazelton & Clark Co. for the construction of two additional factory buildings. One of these is an extension to the foundry and is of the brick and steel type, 60 by 185 feet. This building will provide increased facilities for melting alloys used in manufacturing thermo-couples and as resistance wires in electric furnaces and other electrically heated devices. The other building will be used for the manufacture of electric heat-treating furnaces and pyrometers. This building is of reinforced concrete, two stories high, 60 by 195 feet.

American Bronze Corporation. Berwyn, Pa., maker of non-gran bearing bronze, celebrated the opening of its new plant at Berwyn on August 16. The new plant more than triples the former capacity of the company, is of highly modern construction and equipment throughout, and is planned to make it possible to route the work through the plant so as to insure a maximum output. In connection with the opening of the new plant, a system of war worker's badges was inaugurated for employes who render faithful and loyal service, bronze, silver, and gold badges being employed; employes who have been awarded badges are entitled to cash bonuses. The officers of the American Bronze Corporation are John W. Watson, president and general manager; Matthew C. Dittman, vice-president and treasurer; and Richard A. Watson, secretary and production manager.